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The Engineer

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PUBLIC NOTICES

BOILER.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 23rd September, 1926, for the SUPPLY and ERECTION of a STEAM BOILER at the Forest Products Research Laboratory, Princes Risborough.
Drawings, specification, a copy of the conditions and form of contract and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.). The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3477

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Monday, 27th September, 1926, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at Croydon Telephone Exchange.
Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3500

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. NINE SETS of FLOATING PILE DRIVING PLANT, comprising Pile Driving Frames, Hammers, Boilers, Cranes, &c., mounted on Pontoons.
2. TWO 125 K.V.A., 3300 Volts CRUDE OIL ENGINE ALTERNATOR SETS, with Water Cooling Plant, Switchboard, &c., and Transformers for Cauvery Metur Project.
3. 60 UNDERFRAMES and 70 BOGIES for RAILWAY CARRIAGES.
Tenders due on the 24th September, 1926, for No. 1, on the 1st October, 1926, for No. 2, and on the 4th October, 1926, for No. 3.
Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 3516

Civil Engineer Required to act as GENERAL MANAGER of the BAGHDAD WATER BOARD, IRAQ, for two to three years' service. Free passages and liberal leave on full salary. Salary, Rupees 800 a month, rising by annual increments of Rupees 50. Candidates, 25 to 35 years of age, unmarried, should be Associate Members of the Institution of Civil Engineers or possess equivalent professional qualifications, and have had experience of Piped Water Supplies, Water Clarification and Distribution and a practical knowledge of Diesel Engines. A knowledge of Electrical Work would be an advantage but is not essential.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, quoting M/14,744. 3504

Civil Engineers (5) Required for the PUBLIC WORKS DEPARTMENT of TANGANYIKA TERRITORY for a tour of 20 to 30 months' service, with possible extension. Salary £480, rising by annual increments to £720 a year (with efficiency bar at £600) payable in the Territory in local currency. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, preferably unmarried, must have been regularly trained as Civil Engineers and be Corporate Members of the Institution of Civil Engineers. Must be capable of levelling, surveying, measuring up work and preparing designs of bridges, &c. Must have had at least three years' experience under a qualified Civil Engineer on the construction of Harbour Works, Drainage Works, Water Supply, or other Public Works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London S.W. 1, quoting M/14402. 3472

Draughtsman Required for the PUBLIC WORKS DEPARTMENT of KENYA COLONY for a tour of 30 months' service. Salary £480, rising to £600 a year by annual increments of £20, and thence rising to £720 a year by annual increments of £30. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, must be fully trained and experienced in the office of a fully qualified Civil Engineer, should be experienced in the design of buildings, and be competent to prepare working drawings rapidly and efficiently of large buildings from sketches, should be able personally to undertake engineering survey work.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14371. 3499

Engineer Required by the GOVERNMENT of the GAMBIA to Supervise the Erection of a Slipway at Bathurst, for 12 months' service, with possible extension. Salary £800 a year, free quarters and passages and liberal leave on full salary. Candidates, 30 to 40 years of age, should be A.M.I.C.E. with considerable experience in Harbour and Dock Work, preferably on the Construction of Slipways.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14,787. 3505

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that TOD JOSEPH MELL, a citizen of the United States of America, of 327, Storer-avenue, Akron, Ohio, United States of America, SEEKS LEAVE TO AMEND the Specification of Letters Patent No. 226,209, granted to him for an invention entitled "Method and Apparatus for the Manufacture of Decorative Inlaid Sheeting."
Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) of the 1st September, 1926.
Any person, or persons, may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, W.C. 2, within one calendar month from the date of said Journal.
W. S. JARRATT,
Comptroller-General.
3514 n

PUBLIC NOTICES

Section Engineers (2) REQUIRED for the CONSTRUCTION BRANCH of the FEDERATED MALAY STATES RAILWAYS, for two years' service, with possible extension. Salary 400 dollars a month, rising to 800 dollars a month by annual increments of 25 dollars a month, plus a temporary allowance of 10 per cent. to bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in this country. No income tax is imposed by the Government of the Federated Malay States at present. Free passages provided. Bonus of three months' salary on satisfactory termination of agreement. Candidates, preferably single, aged 25 to 38, must be fully qualified Railway Civil Engineers who have received good training and experience on European, American or Colonial Railways. Members or Associate Members of the Institution of Civil Engineers preferred.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14,804. 3506

The Institution of Structural ENGINEERS.
MODIFIED EXAMINATION FOR ASSOCIATE-MEMBERSHIP.
A MODIFIED EXAMINATION for ASSOCIATE-MEMBERSHIP for candidates of and over 25 years of age who have at least 10 years' experience (including time served in apprenticeship or articles) is HELD QUARTERLY. It consists of an examination in Design worked privately by the candidate in the course of his practice at home. The NEXT EXAMINATION will take place on 18th SEPTEMBER (papers posted on the 17th), and entries must be in by 13th September. Syllabus and full particulars from the undersigned.
MAURICE G. KIDDY,
Secretary of the Institution.
10, Upper Belgrave-street, S.W. 1. 3135

COUNTY BOROUGH OF WEST HAM.
West Ham Municipal College.
SESSION 1926-27.
DAY and EVENING COURSES in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING, under recognised teachers of London University.
Matriculated Students are recognised as "Internal" Students of the University.
Enrolment of students, September 13th to 17th.
Particulars of these and other courses in the prospectus to be obtained from the Principal.
GEORGE E. HILLEARY,
Town Clerk.
18th August, 1926. 3139

PUBLIC NOTICES

City of Cardiff Education COMMITTEE.
THE TECHNICAL COLLEGE.
Principal: CHARLES COLES, B.Sc. (Lond.).
DEPARTMENT OF ENGINEERING.
Head of Department: A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.
SESSION 1926-7.
Commencing on Tuesday, 5th October, 1926.
The following Courses have been arranged for Engineering Students :—
A Three Years' Course in Mechanical and Marine Engineering jointly with the University College of South Wales and Monmouthshire.
A Two Years' Course for Apprentices and others with facilities for practical experience in the Summer Term.
These Courses are suitable for students preparing for Degrees in Engineering or for the Examinations of the Engineering Societies.
Special Courses are also arranged for Marine Engineers preparing for the Examinations of the Board of Trade.
OPEN SCHOLARSHIPS, covering tuition fees and maintenance grants of £40 per annum for three years, are offered for competition annually and candidates for entry to the above Department are eligible to compete.
For further particulars of Full-time and Part-time Courses, Entrance Examination, Scholarships, Fees, &c., apply to the Principal. Application forms for Entrance Scholarship Examination, duly filled up, must be received before September 16th.
JOHN J. JACKSON,
Director of Education.
City Hall, Cardiff. 3195

NORTHERN POLYTECHNIC,
HOLLOWAY, London, N. 7.
PRINCIPAL:—REG. S. CLAY, B.A., D.Sc.
COMPLETE COURSES IN THE DESIGN OF STRUCTURAL STEEL AND REINFORCED CONCRETE STRUCTURES.
Mathematics, Mechanics, Materials.
NEW TERM SEPTEMBER 27TH, 1926.
Fees—£1 10s. per course per session.
Head of Department, T. P. BENNETT, F.R.I.B.A. 3189

PUBLIC NOTICES

UNIVERSITY OF LONDON.
King's College.
FACULTY OF ENGINEERING.
COMPLETE COURSES of STUDY, extending over either three or four years, are arranged in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING for the Engineering Degrees of the University of London and for the Diploma and Certificate of the College.
The four years' Course provides, in addition to the academic training, opportunity for practical training in "Works."
HEADS OF DEPARTMENTS.
Professor G. COOK, D.Sc., M.I. Mech. E., A.M. Inst. C.E., Mechanical Engineering.
C. A. GENEVE, B.Sc., A.M.I. Mech. E., Senior Lecturer.
Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering (Dean).
C. H. LOBBAN, D.Sc., A.M. Inst. C.E., Senior Lecturer.
Professor E. WILSON, M. Inst. C.E., M.I.E.E., Electrical Engineering.
F. S. ROBERTSON, M.I.E.E., Lecturer.
Professor S. A. F. WHITE, M.A. / Professor A. E. JOLLIFFE, M.A. } Mathematics.
Considerable extensions have been made in the Engineering Department. These include a large additional drawing-office, lecture room and laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments, and research rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the Laboratories in the three Departments for purposes of teaching and research.
There is a College Hostel and a large Athletic Ground.
For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 2979

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, E.C. 1.
Evening Courses in ENGINEERING and in FUEL TECHNOLOGY and METALLURGY (including Metallography) for Engineers, Engineering Chemists, &c., commence on Monday, September 20th, 1927.—Prospectuses may be obtained from the PRINCIPAL. 3158

The Polytechnic, 309, REGENT-STREET, W. 1.
SCHOOL OF ENGINEERING.
A Course on
ECONOMICS OF ENGINEERING.
The Course is arranged specially to meet the needs of Engineers who desire to gain a knowledge of Economics as applied to their profession. It also covers the syllabus laid down by the Institution of Mechanical Engineers in that subject, which forms Section C of the Examination for Associate Membership of the Institution.
(a) GENERAL ECONOMICS,
Tuesday, 6.30-7.30.
(b) WORKSHOP ORGANISATION AND MANAGEMENT,
Tuesday, 7.30-8.30.
COMMENCING SEPTEMBER 28TH.
A Course on
DRAWINGS, SPECIFICATIONS AND QUANTITIES.
This Course is designed to suit the requirements of Civil Engineering Assistants and others engaged in similar work. The syllabus of work done is in close agreement with that set down by the Institution of Civil Engineers.
The Class meets on Fridays from 6.30-8, and BEGINS on OCTOBER 1st.
The fee for either Course is £1.
Particulars free on application to the DIRECTOR OF EDUCATION. 3488

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PUBLIC NOTICES

Administrative County of LONDON.

SOUTHERN OUTFALL WORKS, CROSSNESS.
RECONSTRUCTION OF ROOF OF BEAM ENGINE-HOUSE.

The London County Council invites TENDERS for the RECONSTRUCTION of the ROOF of the BEAM ENGINE-HOUSE at the Southern Outfall Works, Crossness (in the Urban District of Erith, in the County of Kent), in Reinforced Concrete supported by Steel Lattice Girders, including the REMOVAL of the EXISTING ROOF and the CONSTRUCTION of a PARAPET WALL.

Persons desiring to submit Tenders may obtain the form of Tender and contract, specification and drawings on application to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £5 by cheque or draft to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 11th October, 1926, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
Clerk of the London County Council.
3476

Bethnal Green Board of GUARDIANS.

EXTENSION OF HOT WATER SUPPLY SYSTEM.

The Guardians invite TENDERS for the EXTENSION of the EXISTING HOT WATER INSTALLATION at their Institution, Waterloo House, Waterloo-road, Bethnal Green, E. 2.

The plan and specification of the work may be inspected at the undermentioned address any week-day between the hours of 10 a.m. and 12 (Noon) and 2 p.m. and 4 p.m. (Saturdays excepted), and a copy of the specification, with form of Tender, will be supplied upon payment of a deposit of £1, which will be returned on receipt of a bona fide Tender.

Sealed Tenders, in envelope marked "Hot Water Supply Extension," must be delivered at my office not later than Twelve (Noon) on Tuesday, 28th September, 1926.

The Guardians do not bind themselves to accept the lowest or any Tender.

C. FAULKNER JONES,
Clerk to the Guardians.

Administrative Offices,
Bishop's-road, E. 2,
2nd September, 1926. 3478

Bethnal Green Board of GUARDIANS.

LAUNDRY MACHINES.

The Guardians invite TENDERS for the INSTALLATION of certain LAUNDRY MACHINES at their Institution, Waterloo House, Waterloo-road, Bethnal Green, E. 2.

Copy of specification, with form of Tender, can be obtained from the undersigned upon payment of a deposit of £1, which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, in envelopes marked "Laundry Machines," must be delivered at my Office not later than Twelve (Noon) on Tuesday, the 28th September.

The Guardians do not bind themselves to accept the lowest or any Tender.

G. FAULKNER JONES,
Clerk to the Guardians.

Guardians' Offices,
Bishop's Road, E. 2.
8th September, 1926. 3521

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—

BOILER TUBES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 3rd September, 1926.

A fee of 20s. will be charged for the specification, which is not returnable.

Tenders must be submitted not later than Noon on Thursday, 16th September, 1926.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
Secretary.
3491

The Madras and Southern Mahratta Railway Company, Limited,

25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—

(i.) EIGHT BOGIE CARRIAGE UNDERFRAMES, FOUR 4-WHEELED BRAKE VAN UNDERFRAMES, and 4-WHEELED UNDERFRAME (Without Wheels and Axles), Metre Gauge.

(ii.) 22 PAIRS WHEELS and AXLES for CARRIAGES and WAGONS (to be fitted with Sandberg Sorbitic Steel Tyres).

Tenders are due in on Tuesday, 28th September, 1926, by 2 p.m. Tender forms obtainable at above address ; fee for No. (i.) One Guinea and for No. (ii.) Half-a-Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 3498

Limerick Harbour Commissioners.

APPOINTMENT OF HARBOUR ENGINEER.

APPLICATIONS from competent and experienced CIVIL ENGINEERS are INVITED for the POSITION of ENGINEER for the Port and Harbour of Limerick. Candidates must possess a Degree in Civil Engineering from a recognised University or be a full Member of the Institution of Civil Engineers of Ireland or England, and must have been engaged in a responsible position in engineering works of considerable magnitude, preferably dock or harbour, for a reasonable period of not less than five years. The appointment is a "whole-time" one and the salary £600 per annum ; no other fees or emoluments. List of duties and conditions of appointment may be obtained from the undersigned.

Applications, stating age, with copies of testimonials in sealed envelopes, marked "Application for Harbour Engineer," to reach the Harbour Office, addressed to the Chairman, on or before Saturday, 2nd October, 1926.

JOHN F. POWER,
Secretary.
Limerick Harbour Commissioners.
3490

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, ENGINEERS' COMMERCIAL CLERK, one experienced in costing, estimating, bookkeeping, with knowledge of mechanical drawings, active. To one of initiative, progressive post assured. —Address in confidence, stating abilities, age, experience, P2234, The Engineer Office. P2234 A

WANTED, MINING ASSISTANT to the General Manager of an Opencast and Underground Iron Ore Property in the East. Candidates should have had previous practical experience, and a sound technical education. Applicants to give details of past experience and other qualifications, with references, and state salary required. Furnished single quarters are provided, and the employee receives an allowance sufficient to cover the cost of living at the mine.—Address, 3454, The Engineer Office. 3454 A

PUBLIC NOTICES

TRACING CLOTH.

INFRINGEMENT OF TRADE MARK.

UNDERTAKING AND APOLOGY

[COPY]

APOLOGY FOR INFRINGEMENT OF TRADE MARK.

APOLOGY

TO MESSRS. THE WINTERBOTTOM BOOK CLOTH CO., LTD.

13th August 1926.

GENTLEMEN,

We, Edward Henry Blyth and Harriette Schery trading as H. Blyth & Company at 134, Deansgate, Manchester, Drawing Office Stationers, admit that we have offered for sale and sold tracing cloth bearing a single red line at each selvedge in infringement of your Trade Mark of a single red line at each selvedge of tracing cloth which has been in use by you for over fifty years past, and which is also your registered Trade Mark No. 448644 in Class 39 in respect of tracing cloth.

We regret that we have infringed your Trade Mark and apologise to you therefor.

We have removed from all tracing cloth in our possession the single red line from each selvedge and have handed the selvedges so removed to your representative.

We undertake that we, our servants and agents will not again infringe your registered Trade Mark above mentioned in respect of tracing cloth and that we will not sell or offer for sale any tracing cloth not of your manufacture or merchandise so marked or got up as to be likely or calculated to mislead or deceive the public into the belief that the said tracing cloth is your goods and that we will not pass off or enable others to pass off tracing cloth not of your manufacture or merchandise as or for your goods.

We agree to pay you forthwith Ten Guineas as damages and to pay as between Solicitor and Client all Costs incurred by you including the Costs of your publishing this apology in any two papers which you may select and we consent to such publication.

(Signed)
E. H. BLYTH.
H. SCHERY.

SIGNED by the said Edward Henry Blyth and Harriette Schery in the presence of :
H. FRANCIS, 17, Apollo St., Oldham Rd., M/chr., Clerk.
3457

SITUATIONS OPEN (continued)

WANTED, a CIVIL ENGINEERING ASSISTANT for Waterworks Construction.—Address, stating age, experience, and salary, 3473, The Engineer Office. 3473 A

WANTED, SECOND ENGINEER for Argentine ; first-class Refrigerating and Electrical knowledge essential. Spanish not essential, but must be learnt.—Address, P2237, The Engineer Office. P2237 A

ASSISTANT MANAGER WANTED by Marine Engineers, Dry Dock Owners and Ship Repairers in China. Aged about 35.—Address, detailing experience and qualifications for this position, P2236, The Engineer Office. P2236 A

ASSISTANT TO GENERAL MANAGER.

THE MANAGING DIRECTOR of a Large Works engaged in the manufacture of Heavy Railway Machine Tools and Electric Cranes REQUIRES the ASSISTANCE of a GENTLEMAN thoroughly qualified both technically and commercially. A commencing salary of £1200 per annum is proposed, with excellent prospects.

Applications will be treated in strict confidence and should give age and full particulars of experience Address in first instance, 3518, The Engineer Office. 3518 A

CIVIL ENGINEER, with Special Knowledge of Brick Buildings, WANTED, for first-class English contracting firm in India. Excellent prospects. Public school man preferred. Aged 28, unmarried. Five years' agreement.—Write, with copies of testimonials and photograph, if possible, to Box Z. Z. 645, c/o Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 3515 A

CONTRACTORS' ENGINEER REQUIRED IMMEDIATELY by Public Works Contractors. Must have considerable outside experience and be reliable estimator on building as well as engineering works. Knowledge of Reinforced Concrete essential. Age 30-40 years.—Address, with full particulars of experience and salary required, 3497, The Engineer Office. 3497 A

CYCLE TRADE.—ASSISTANT WORKS MANAGER WANTED, for Frame and Machine Erecting Department of large Birmingham Factory. Must be capable of handling 400 to 500 men, previous cycle trade experience an advantage, but essentials are initiative, tact and discipline. Good and permanent prospects to energetic man with above qualifications.—Address, stating age and experience, 3517, The Engineer Office. 3517 A

POWER ENGINEER REQUIRED by Manufacturing Firm in North-East London. Experience with Babcock and Wilcox Boilers essential. Salary £400 to £450.—Apply by letter, stating age, qualifications and experience, P2228, The Engineer Office. P2228 A

POWER-HOUSE SUPERINTENDING ENGINEER REQUIRED for Industrial Plant, 2500 K.W. D.C., having good experience of Water-tube Boilers, Turbines and Reciprocating Engines.—Address, stating qualifications and experience, with copies (only) of testimonials, stating salary required, P2241, The Engineer Office. P2241 A

RAILWAY SIGNAL ENGINEER.—Experienced all branches, especially lock and block system, REQUIRED for the Peking-Mukden Railway (Chinese Government Railways). Age 30-35, three years' agreement. Salary £600, £700, £800. Applicants must apply in writing, giving age, married or single, detailed statement of education, training, and experience.—Address, 3499, The Engineer Office. 3499 A

SITUATIONS OPEN (continued)

REQUIRED by Large Oil Company, a THOROUGHLY QUALIFIED and CAPABLE ENGINEER, with Designing and Operating Experience in Refinery Plant. Must have held responsible position. —Apply in writing, with full details of experience and copies of testimonials, to Box "D," c/o The Regent Advertising Service, Ltd., 165/167, Moorgate, E.C. 2. 3520 A

DRAUGHTSMAN, Leading, Experienced in Locomotive Design and preferably with knowledge of Railway Carriage and Wagon Manufacture. Give particulars of experience, age, and salary required.—Address, 3483, The Engineer Office. 3483 A

DRAUGHTSMAN REQUIRED for London Office, used to Boiler Installation Lay-outs. Quote experience and salary required.—Address, P2235, The Engineer Office. P2235 A

DRAUGHTSMAN, Senior, REQUIRED by Engineering Firm, Glasgow district ; up-to-date practical experience in design and manufacture of Steam Fittings for high pressures and superheat. State age, experience, and salary required.—Address, 3484, The Engineer Office. 3484 A

DRAUGHTSMAN WANTED by Confectionery Firm accustomed to General Engineering Work (Machinery Design and Plant Lay-out). Five days week, £4 5s., rising to £5 after six months.—Address, 3500, The Engineer Office. 3500 A

EXPERIENCED SENIOR and ASSISTANT DRAUGHTSMEN REQUIRED.—Apply in writing to the CHIEF DRAUGHTSMAN, Redpath, Brown and Co., Ltd., Constructional Engineers, Trafford Park, Manchester. 3482 A

OIL ENGINES.—Experienced DRAUGHTSMEN REQUIRED at once for Detail Work on Heavy Oil Engines ; must be accustomed to calculating Stresses, &c. State full details of experience, age and salary required.—Address, 3511, The Engineer Office. 3511 A

STRUCTURAL DRAUGHTSMAN WANTED AT ONCE. Must be well up in the theory and practice of Reinforced Concrete and Steel as applied to industrial buildings. Mechanical experience also an advantage.—Address, stating age, experience, and salary required, 3502, The Engineer Office. 3502 A

WANTED, URGENT, WORKING FOREMAN, to Take Charge Engineering Dept. of Small Marine Repair Yard, about 20 hands, fitters, turners, smith shops, small foundry. House goes with appointment. Only thoroughly experienced engineers in all classes of marine work with first-rate references need apply. —Address, 3494, The Engineer Office. 3494 A

SITUATIONS WANTED

ADVERTISER WISHES to IMPROVE POSITION. Good all-round shop and drawing-office experience. Knowledge of wireless, 30 yrs. — Address, P2240, The Engineer Office. P2240 B

A.M.I. MECH. E. SEEKS POSITION ; 20 Years' experience, installation, operation, repairs, steam plants, oil fuel, oil engines, material handling, waterworks, foundations, general machinery. Manage men, accustomed entire charge ; A1 refs.—Address, P2218, The Engineer Office. P2218 B

BOILER ATTENDANTS, ENGINEERS, SHOWROOM HANDYMEN and CLEANERS.—For reliable time-expired Service men *write* :—NATIONAL ASSOCIATION FOR EMPLOYMENT OF REGULAR SAILORS, &c.,
(Room 6), Dock-road, Chatham.
(Secretary, Commander Darwall, R.N.)
Telephone, Chatham 10. All trades. No fees. P1996 B

ENGINEER (25), Public Schools, 7½ Years' Shops and commercial experience, DESIRES POST with sound commercial motor or general engineers. Good knowledge of purchasing, stores organisation, progress, &c. Highest references. Small salary at start.—Address, P2239, The Engineer Office. P2239 B

WORKS MANAGER and ENGINEER, A.M.I. Mech. E., both DESIRE POSITION where initiative and varied experience is wanted. Experienced general engineering, conveying and elevating plants. Good commercial knowledge. Highest references.—Address, P2238, The Engineer Office. P2238 B

WORKS MANAGER DESIRES CHANGE, 15 Years' experience as works manager in first-class engineering firms ; specialty, output, organisation, and efficiency.—Address, P2169, The Engineer Office. P2169 B

YOUNG ENGINEER (23), Public School, 7 Years' practical experience with leading general engineering firm, fully qualified draughtsman, cement machinery, elevators and conveyors, structural work, &c., READY to UNDERTAKE any WORK offered. Small capital if required.—Address, P2216, The Engineer Office. P2216 B

DRAUGHTSMAN (London District) REQUIRES SITUATION ; 21 years' good all-round engineering experience.—Address, P2232, The Engineer Office. P2232 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Unemployment Grants.

THE fifth report of the Unemployment Grants Committee shows that during the year ended June, 1926, there was a considerable falling off in the number and value of the applications for assistance received by the Committee from local authorities, public utility companies, &c. During the year 1739 applications of an aggregate value of £17,900,000 were received. Previously the average annual number of applications was about 4020 and the average annual value about £30,000,000. The Chairman of the Committee, Viscount St. Davids, commenting on this reduction, says that apparently the unemployment grants scheme, after being in operation for six winters, has now passed the period of its greatest usefulness, and that to continue it indefinitely on the same scale as in the past would make it difficult to avoid subsidising work properly undertaken by local authorities in the normal course of their business, with the result that little would be added to the sum total of work in the country. In addition, special schemes conducted with the assistance of a grant might tend to divert capital from the normal trade developments now anticipated, and might therefore hinder rather than assist the relief of unemployment. Since the Committee began its work in December, 1920, it has dealt with nearly 18,000 separate schemes of work of a total capital value of over 136 million pounds. Of these schemes it has approved of 12,700, representing a capital value of over 104 million pounds. On the approved schemes the State assistance amounts to the total of about 40 million pounds. It is estimated that the amount of direct employment provided by the approved schemes is approximately 4,000,000 man-months, while in addition at least as much employment again has resulted from the preparation of materials in factories, quarries and elsewhere.

A Huge Suspension Bridge.

ACCORDING to a statement made within the past few days by Mr. S. N. Rice, a member of the New York Port Authority, now in this country, two large suspension bridges are to be erected by the Authority at a total cost of nearly £14,000,000 for the purpose of dealing with the increasing volume of cross-river traffic at New York. One of the bridges, to cost £3,600,000, will connect New Jersey and Staten Island and will be three-quarters of a mile long. The second will cross the river Hudson at a point where it is three miles wide. It will cost about £10,000,000 and will be 300ft. high in order to permit large steamers to pass beneath it. The smaller bridge will, Mr. Rice states, be begun immediately and will be finished in about three years. The large bridge will apparently not be commenced for some time, but it is anticipated that once begun it will be completed in from four to five years. It will be the longest suspension bridge in the world. How many spans it will have has not been stated. The celebrated Brooklyn suspension bridge has a central suspended span of 1595ft. and two end suspended spans of 930ft. each. The Williamsburg bridge, also across the East River at New York, has a span of 1600ft. and a total length of 7200ft. Both these existing bridges have a head clearance of 135ft. for the passage of ships. The 300ft. mentioned by Mr. Rice in connection with the new bridge is presumably the maximum height of the bridge structure above water level.

Industrial Casualties.

IN his annual report for the year 1925, Sir Gerald Bellhouse, Chief Inspector of Factories, records that in the twelve months there were 159,693 accidents in industry, of which 994 proved fatal. The casualties were some 10,000 fewer than in 1924, but the reduction was confined to certain districts only and is to be accounted for in large measure by the depression in the iron and steel and shipbuilding industries. Building operations contributed the largest number of fatal accidents to the total, the number being 142, and work at docks came second with 93. Of the building fatalities the majority were caused by falls from working platforms. A considerable proportion of them occurred in the London district, where very extensive reconstruction work is being carried out, involving employment at dangerous heights. We learn with interest that the peculiar risks involved in building operations have been recognised for some time and that a comprehensive code of regulations framed to meet them has been practically agreed upon with the industry and, it is hoped, will soon be in force. It is also of interest to note that, according to Sir Gerald's report, cranes cause more deaths than any other form of mechanism used in industry, and that a committee of the Engineering Standards Association is to be set up to investigate the matter. For the past few years it has been no uncommon sight in London to see the members of a steel-framed building being hoisted from the road level over the heads of pedestrians and the passing traffic without any precautions whatever being taken to minimise the results of a mishap. It is perhaps fortunate that the public generally fails to realise the risks involved, for if it did it would lose the complacency with which it enjoys these spectacles. That the men employed on the erection of the framework fully deserve the title of the "shock troops" of the building industry, which was applied to them at an inquest some time ago, will be granted by anyone who has seen them at work climbing a new erected column by means of their hands and toes with no more foothold than that provided by the rivet heads.

Motor Fuel Progress.

TWENTY-TWO vehicles running on all kinds of fuels except petrol and mineral oils have started from Paris on a two weeks' tour through the north-west departments and will no doubt demonstrate once again that it is quite possible to run motor cars successfully on home-produced fuels. Most of the vehicles are equipped with suction gas plants using wood or charcoal. Others run on acetylene and some on alcohol. The "national fuel," composed of a mixture of alcohol and petrol, is also represented, as well as one or two patented liquid fuels. The object of the demonstration is mainly to impress upon the public the advance that has been made in the efforts to replace imported oils with home-produced fuels, and it will also certainly have great technical value in providing data as to the economy and suitability of the various fuels employed. There is, nevertheless, already sufficient evidence that motor cars can run on petrol substitutes. The real problem involved lies solely in producing the substitutes in sufficient quantities and at a low enough cost.

An Industrial Conditions Delegation.

ON Friday of last week, September 3rd, Sir William Mackenzie accompanied by Mr. F. W. Leggett, of the Ministry of Labour, and Mr. I. H. Mitchell, of the same Department, with Mr. H. C. Emmerson as secretary, sailed from Liverpool to begin work on behalf of the Government as a delegation inquiring into the industrial conditions and the relationship between employers and employed in the United States and Canada. The delegation will be complete in a few weeks time, when it is joined by Mr. Ernest Bevin, of the Transport and General Workers' Union; Mr. B. V. Dewar and Mr. J. Naylor, of the Amalgamated Engineering Union; and Mr. Randolph Smith, of Barclay, Curle and Co., Ltd. The delegation will be absent from this country for three or four months, and on its return will submit a report to the Government which, it is hoped, will do something to promote satisfactory industrial relations in this country. Its work will not be confined to any particular industry.

Smoke Abatement.

THE Universal Smoke Abatement Exhibition, which opened in the Bingley Hall, Birmingham, on Monday, the 6th inst., and continues until the 18th, is of considerable interest to both engineers and the public in general. A considerable proportion of the exhibits is, of course, quite technical; such, for instance, as the equipment of the model boiler-house, towards the arrangement of which some twenty manufacturers have contributed, while there are examples of powdered coal firing and oil burning furnaces; but the domestic side of the problem is well represented. The Birmingham gas and electricity departments have naturally large displays. Another joint exhibit is contributed by a number of electrical undertakings and firms, part of which consists of model rooms of an "all-electric" house, containing domestic labour-saving appliances. During the course of the Exhibition lectures will be given on the following subjects:—"Industry and Smoke Abatement," "Housing and Smoke Abatement," "Smokeless Production of Heat and Power," "Electricity and Health," and "The Contribution of the Gas Industry to Smoke Abatement."

Foreign Naval Contracts.

A PARIS message regarding activity at the Chantiers Naval Français, at Blainville, comes as a reminder that a good deal of naval shipbuilding for foreign Governments is now in progress in continental yards. At the French establishment in question two destroyers for Poland, a submarine for Greece, and two large oil tankers for Russia are under construction. Other French yards are building two submarines and two mine-layers for the Lithuanian Government and two submarines for Greece, while the Greek cruisers Averoff and Helle are to be extensively reconstructed at the Forges et Chantiers de la Mediterranée. An Italian yard has secured the order for a Greek mine-layer, and a second vessel of this type is on the stocks at Rotterdam. It is believed that other naval craft for the minor States are on order in France and Italy. Two submarines for the Peruvian Navy have just been completed in the United States, where, also, the two largest Argentine battleships have recently undergone modernisation at a very heavy outlay. External naval contracts booked by British firms since the war have been limited, we understand, to a gunboat for Siam, a number of coastal motor boats for various Governments, and the reconditioning of Greek destroyers. While the meagre proportion of foreign naval orders which has fallen to British yards in recent years is regrettable, it is well to point out that the allocation of such work is now governed by political motives to a much greater extent than formerly, and that if the awards were made on competitive grounds alone the British share would certainly be larger than it is.

The Coal Dispute.

THE position in the coal dispute has undergone a considerable development during the past week, although it is evident that the road to peace has not yet been fully found. Following the meeting on Thursday of last week between the Executive Committee and the special delegate conference of the Miners' Federation, Mr. A. J. Cook, on behalf of the miners, wrote to the Chancellor of the Exchequer asking him to convene and attend a conference of the Mining Association and the Miners' Federation. The miners, Mr. Cook added, were prepared to enter into negotiations for a new national agreement, "with a view to a reduction in labour costs to meet the immediate necessities of the industry." This letter, in the opinion of the Government, afforded a basis for the resumption of negotiations, but when an endeavour was made to arrange an immediate tripartite conference, the Mining Association raised a difficulty by informing the Government that it no longer had authority to discuss questions of employment on behalf of the district colliery owners' associations. A meeting of the Cabinet Coal Committee and representatives of the Mining Association to explore the position was held on Monday, the 6th. The owners' representatives made it clear that they were strongly opposed to a national agreement, and that there was little prospect of their departing from their policy of district agreements. They agreed, however, to remit the issue to the district associations for their opinion. It is hoped that the Central Committee of the Mining Association will be in a position to consider the views of the local bodies on Monday next.

Germany's Industrial Position.

AFTER an absence abroad, Dr. Duisberg, one of the leaders of the German dye industry and chairman of the Association of German Industrialists, addressed a meeting of that Association at Dresden last week and reviewed Germany's economic and industrial position. His statement was not by any means a rosy one. He found the position of the country as a whole worse than when he left it. The engineering industry, he said, had shown no improvement and was showing signs of becoming less prosperous. The iron and steel industry was in an extremely bad position, unemployment in the principal centres ranging from 40 to 86 per thousand of the population. In the dyestuff industry conditions were very unsatisfactory, the turnover being less than half of the average. The export coal trade had improved as a result of the British dispute, but the home demand for coal remained very unsatisfactory. On the whole the position of the electro-technical industry was satisfactory, but the paper and textile industries were suffering from a lack of prosperity with the exception of the silk, artificial silk, and velvet branches. The increasing requirements of a growing population and the country's obligations in the matter of reparations payments could, Dr. Duisberg declared, only be met if exports showed a surplus of over £150,000,000. He recommended that strict all-round economy should be observed and that imports should be reduced to the lowest possible level.

The Motor Ship Wulsty Castle.

ON Wednesday, September 8th, the recently converted steamship Wulsty Castle, which is now fitted with twin Beardmore-Tosi four-stroke double-acting marine oil engines, geared to the propeller shaft through Beardmore-Vulcan hydraulic clutches and single-reduction gearing, ran her trials on the Skelmorlie mile. Her machinery was built by the Vulcan Works of Hamburg, under licence, and she recently made a good voyage to Dalmuir. She is a single-screw ship of 6300 tons deadweight carrying capacity, and about 3566 tons gross, and is managed for the owners by James Chambers and Co., of Liverpool. Her two engines are each three-cylinder units, and are designed for a total output of 1700 shaft horse-power. The cylinders have a diameter of 20½in., with a piston stroke of nearly 24½in., and the full power is developed at the more than usually high speed of 245 revolutions per minute. The oil-operated hydraulic mechanical clutches, together with single-reduction gear, reduce the engine speed to a normal propeller speed of 80 revolutions per minute. The arrangement of machinery is of interest, representing as it does a new high-speed oil engine of the double-acting type, which, by means of the transmission gear described, provides a wide range of flexibility for manœuvring purposes. The auxiliaries are both steam and oil engine driven, steam being employed for the deck machinery. The trial results of this ship will be awaited with interest.

London Electric Railways: Extensions.

No. III.*

THE MORDEN EXTENSION OF THE CITY AND SOUTH LONDON RAILWAY (*continued*).

In our last article we traced the building of the Morden extension from the present terminus at Clapham Common as far as Dorset-road—which is about 790 yards short of the further end of Morden Station—and where the construction in cast iron tunnel ceases.

A point that calls for mention before proceeding further is concerned with the fact that the railway rises from Colliers Wood until Morden Station is reached. To guard against the tunnels being flooded by water in consequence of an abnormal fall of rain in the upper area, a pump house and sump have been provided near Dorset-road, and a similar provision made at Kenley-road, which is 1460ft. on the Morden side of Dorset-road.

Each of the pump houses is fitted with two of Tangye's vertical centrifugal bore-hole pumps, which are driven by 600-volt direct-current motors. Power can either be obtained from the traction supply or from the feeder line for the Morden car shed. The latter is itself fed from either the sub-station at South Wimbledon or through the escalator feeders from Stockwell sub-station. The pump is suspended in the sump from the motor base, which is in the pump room above, by means of the suction pipe, through which passes the main shaft. That arrangement avoids the lining up of the shaft in the well and it makes the whole pump and motor a self-contained unit, while at the same time it permits of the pump being readily lifted for examination or cleaning. The capacity of each pump is 600 gallons per minute, and the machines have been installed by the railway company's mechanical engineer's department.

* No. II. appeared August 13th.

The contract for the work from Dorset-road to the south end of Morden Station was let to The Foundation Company, Ltd., the firm which has carried out the length between Tooting Broadway and Dorset-road. It covers a distance of about 1940ft., of which the southern 1600ft. are in tunnel. That length is not, however, in an ordinary tube tunnel, but in reinforced concrete twin tunnels constructed in cut-and-cover by somewhat novel means. It is necessary first to observe that whilst a minimum space of 3ft. is given between two tubes built in iron, there was not the same necessity to separate the twin cut-and-cover tunnels to that extent. The dividing wall has therefore only been made 12in. thick. This reduction had an advantage in that the amount of excavation necessary was also reduced. The transition from an overall width of 28ft. to one of 25ft. 9in. had, however, to be made gradually, and that was done by a bell-mouth, 185ft. long, a drawing of which is given in section A A in Fig. 18. The distance from the inside of the outer wall to the centre of the track was constant at 6ft. 2½in., but from centre to centre of the two tracks it tapered from 15ft. at the Dorset-road end to 11ft. 3½in. where the twin tunnels actually commenced. Fig. 28, page 278, is a view showing the end of the iron tunnel and the commencement of the cut-and-cover at Dorset-road.

Section B B in Fig. 18 gives details of the twin tunnels, and section D D shows the end where the railway comes out into the open at a point about 330ft. from the north end of Morden Station platforms. About 140ft. from the southern end of the tunnels the line passes under Kenley-road and section C C shows the work there. Fig. 29, page 278, shows the end of the southbound cut-and-cover tunnel.

The nature of the ground was such that it was not advisable to construct the railway in an ordinary railway cutting. For about 20ft. from the surface the subsoil consisted of gravel and sand full of water, with blue London clay underneath. That class of ground is eminently suitable for the use of steel piles, and the British Steel Piling Company's 15in. by 15in. section was adopted to make each side of the trench water-tight during construction and to permit the struts to be so arranged as to enable concreting of the twin tunnels to be carried out without having to change the timber, as would have been the case in an ordinary timber trench.

Fig. 19—for the original of which we are indebted to The Foundation Company—shows the procedure in the construction of the twin tunnels. The interlocking steel piles first were driven as shown in the detail in the upper part of the drawing. The depth driven was from 20ft. to 25ft. The excavation followed and 12in. by 12in. struts put in at 6ft. centres, as shown in the cross section E F, after which the concrete bed and drain under were made. Lengths of ¾in. rough boarding were fixed, as seen in the half cross section A B, and as also to be noted on the left and right in the view Fig. 22. Between the rough boarding and the piles sand packing was placed. As soon as the floor was set the reinforcing bars for the side and centre walls and for the roof were placed in position.

To understand how the shuttering of the concrete for the cut-and-cover twin tunnels was carried out, it is advisable to refer to the half cross section A B in Fig. 19, the view Fig. 30—page 278—and the illustration Fig. 20. The Blaw-Knox method, making use of steel articulated tunnel "blawforms," as supplied by Christmas and Walters, Ltd., was employed by The Foundation Company. We are indebted to the former firm for the drawing from which Fig. 20 has been prepared, and which shows the form both expanded and collapsed.

A travelling framework, mounted on a trolley on a 4ft. 6in. track—as seen in Fig. 20 and as shown dotted in the half-section A B in Fig. 19—carries the blawforms so that they can be handled for fixing, striking, collapsing and travelling. As shown in Fig. 19 and on the right in Fig. 20, the form is collapsed and ready for travelling. When the frame is in the requisite position for the form to receive

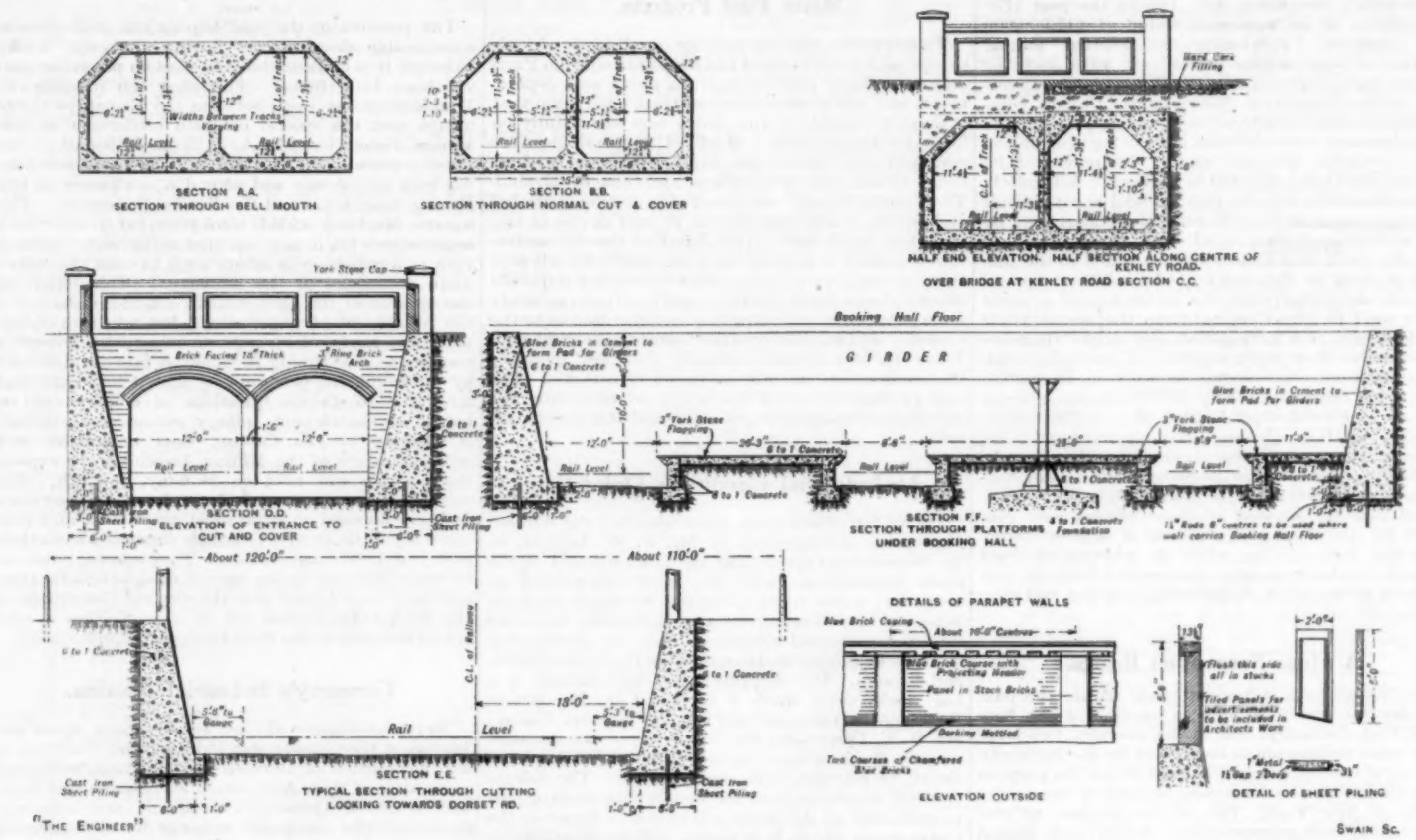


FIG. 18—CROSS SECTIONS OF VARIOUS PARTS OF LINE

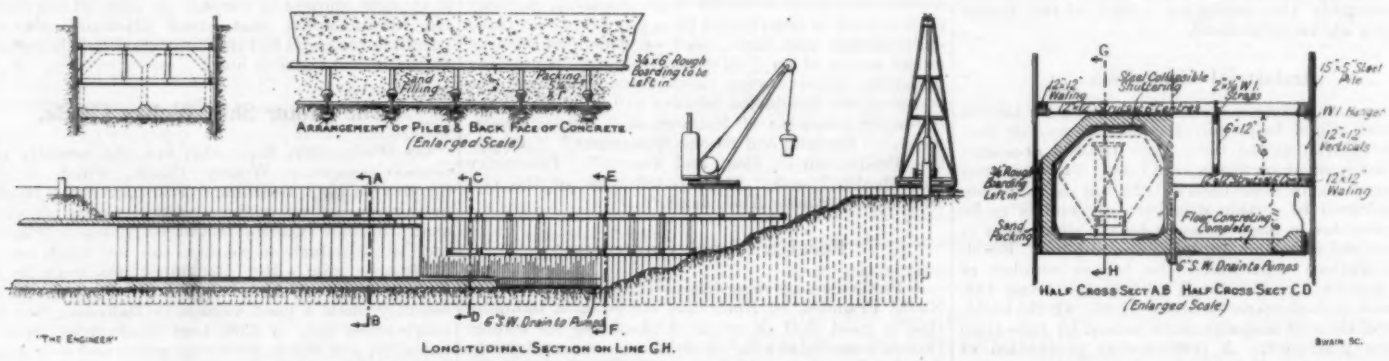

ARRANGEMENT OF PILES & BACK FACE OF CONCRETE.
(Enlarged Scale)
LONGITUDINAL SECTION ON LINE G H.
HALF CROSS SECT A B
HALF CROSS SECT C D
(Enlarged Scale)
"THE ENGINEER"
SWAIN Sc.

FIG. 19—DIAGRAM OF METHOD OF PROCEDURE IN CONSTRUCTION OF CUT-AND-COVER TWIN TUNNELS

concrete, it is as illustrated on the left in Fig. 20 and as seen on the left in the half-tone engraving, Fig. 30, page 278. The form has been raised to the necessary height and the sides expanded by means of screws carried by the travelling frame. The side panels, position for six days. The form in (1) will then be collapsed to the position shown in firm lines in the right-hand illustration and moved from the work at (1) through that done under (2) and (3) to the next 20ft. length, which would be (4), and so on in 20ft. between two retaining walls, each 800ft. long. These walls were built as illustrated in Figs. 21 and 22, for the drawings of which we are also indebted to The Foundation Company. After the base of the wall had been built for 8ft. and had set, the shuttering was lifted clear. Another length of wall was then done, and the shuttering lifted accordingly, and so on until the wall was completed.

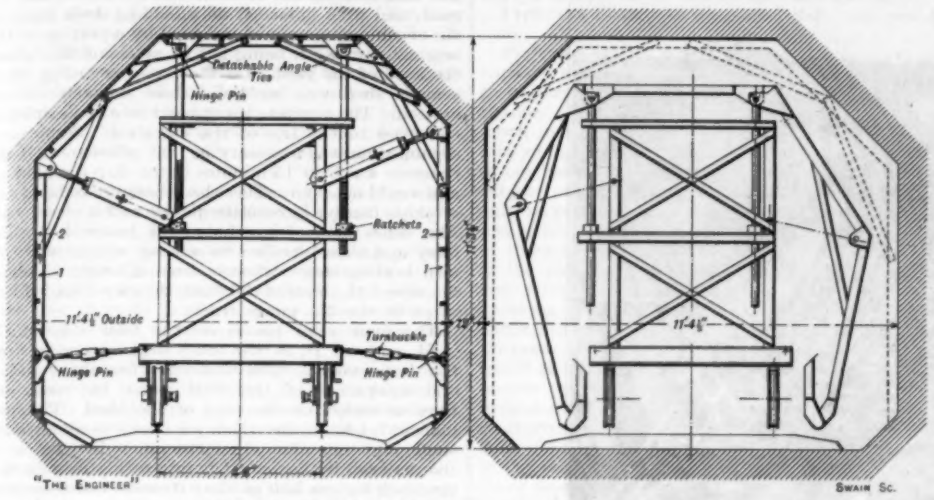


FIG. 20—GENERAL ARRANGEMENT OF ARTICULATED FORMS

numbered 1 and 2, on the straight side and division walls, are independent of the main form and removable. They are placed in position subsequently as the concrete rises and are generally referred to as the loose lagging plates. The upper sides of the lengths. The outer roof of the tunnels is then earthed in and the piles withdrawn.

On the right in Fig. 30, page 278, the blawform is in position and the travelling frame has been moved forward. On the left the frame is engaged in fixing

From the south end of the iron tunnels at Dorset-road to the end of the Foundation Company's contract at the south end of Morden Station about 68,000 cubic yards of material were removed. Some difficulty was experienced during the construction of the main tunnels on contracts north of Dorset-road in getting rid of the excavated material, all of which had to be handled over the public main roads in lorries. It was therefore decided by The Foundation Company, when a general scheme of operations on this contract was under consideration, to eliminate, if possible, all carting over the roads. Arrangements were made with the owners of an old gravel pit for the dumping of the excavated material, and for the conveyance of the material, an aerial ropeway was erected, passing over Epsom-road, a park, and the Merton–Tooting branch of the Southern Railway, a distance of something over half a mile. By that means the excavation was speedily and economically handled, and no damage was done to the roads. In addition to the 68,000 cubic yards above referred to, some 14,000 cubic yards from the tunnel shaft at Dorset-road were also passed over this aerial ropeway to the dump. The ropeway was supplied by R. H. Pierson, Ltd., now amalgamated with Ropeways, Ltd.

The section E E in Fig. 18 illustrates a typical elevation of the retaining walls, as viewed when looking from the station towards the tunnels, as in the view Fig. 31, page 278. Section F F is an elevation as seen in the opposite direction, i.e., towards Morden station yard. In addition to the retaining

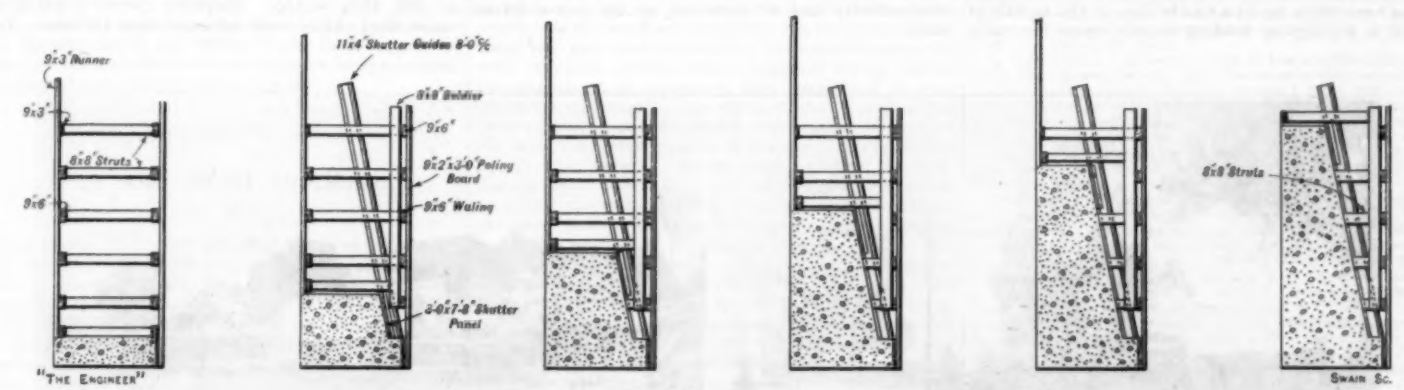


FIG. 21—METHOD OF SUPPORTING TIMBERS WHILE CONCRETING RETAINING WALLS

form that make the sloping sides of the roof are held in position by detachable angle ties.

The procedure is as follows:—(1) Erect a 20ft. length of form in each tunnel and brace it together, as shown in full lines in the left-hand illustration, Fig. 20; provide a bulkhead and pour concrete. (2) Strike the bulkhead; detach the form from the travelling frame, and move the latter forward 20ft.; erect a further 20ft. length in each tunnel; refix the bulkhead and pour concrete. (3) Repeat the operation (2). The time taken for each 20ft. length is approximately two days, so that when the section under (3) has been done that under (1) has been in

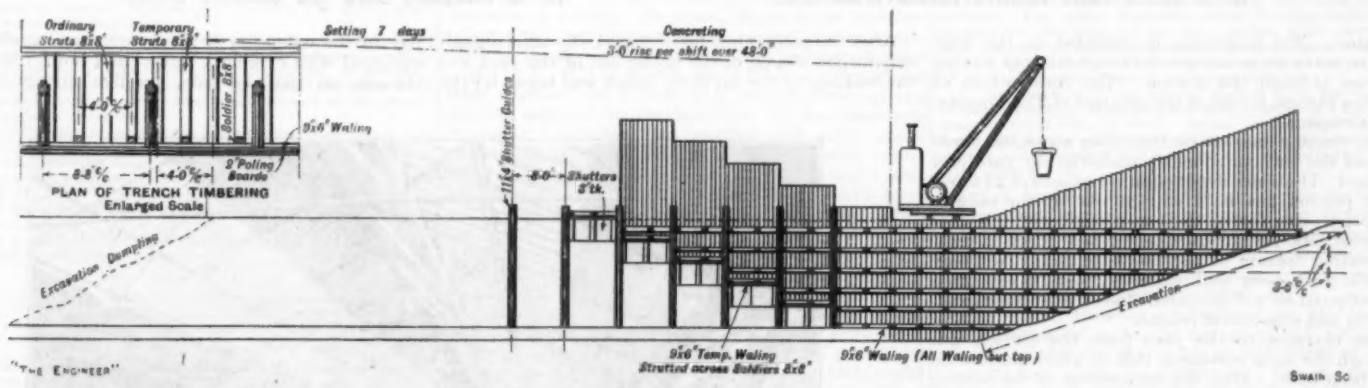


FIG. 22—SECTIONS SHOWING RETAINING WALL CONSTRUCTION

forcing bars in place, the roof and side wall reinforcements in position, the collapsible shuttering being got ready, the concreting of the roof and sides, the withdrawal of the blawform, the refilling of the earth over the roofs of the tunnels and the drawing of the piles.

The line from the southern entrance to the twin cut-and-cover tunnels and through the station is

walls there are seen the three platforms and one of the girders that carry the station buildings. Fig. 24 is a view of the retaining walls taken from the mouth of the tunnel in Fig. 29 and Fig. 31, page 278, is a view in the opposite direction, taken from Morden Station. In the latter the entrances to the cut-and-cover tunnels are seen in the distance.

The lay-out of Morden Station is shown in the sketch, Fig. 23, which may be read in association with the view in Fig. 29. There are three platforms and three platform roads. Two of the latter permit arriving passengers to alight from a train on one side and departing passengers to enter the train

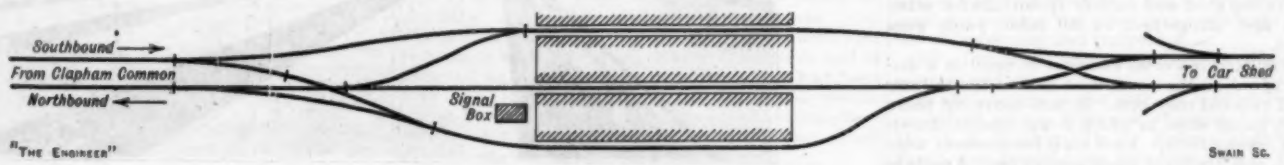


FIG. 23—LAY-OUT OF MORDEN STATION

from the other side. Each of the three roads can be used for arrival or departure. The platforms are 400ft. long. The station buildings abut on the main road—the London and Epsom road. Access between the station entrance and the middle platform is obtained by a direct stairway. The two outer platforms have steps up to a footbridge, in the middle of which is a gangway leading to and from the main

FIG. 24—CUTTING NEAR MORDEN STATION FROM EXIT OF SOUTHBOUND TUNNEL

entrance. The footbridge is extended on the west side to serve as an independent exit without having to pass through the station. The construction of Morden Station is part of the contract of The Foundation Company.

The running lines are continued for about 660 yards beyond the station, so as to reach the car yard and car shed. The whole depôt occupies an area of 23 acres. That portion has been carried out by the railway company's own forces, to plans prepared by the chief engineer, Mr. Arthur R. Cooper, and forms a most interesting feature of the new extension. Not only has the work been well conceived, but its execution was effected on well-prepared lines that secured expeditious and economical results.

The entrance to the yard from the station was through the same cutting as that in which the station had been built. After the termination of the cutting there was a length practically level, after which the ground again commenced to rise, and at the boundary of the company's property was 12ft. deep. From the total area of the yard 78,100 cubic yards of earth were removed, of which 12,000 cubic yards were in the approach. In addition to the foregoing, about 11,000 cubic yards were removed to allow for the examination pits in the shed and further quantities for other purposes, and, altogether, 94,150 cubic yards were excavated.

The excavated material was sent to spoil in a disused brickyard on the north-west side of the railway and filled two old clay pits. It was conveyed there in the 2ft. gauge skips in which it was loaded, drawn by petrol locomotives. Four such locomotives were employed, and 2 miles of track were in use. A feature of note was that the tracks had to cross the main road. The consent of the Surrey County Council was obtained to that being done, and the passage of the train was protected by a flagman—Fig. 25. The road was crossed very quickly, and only 10 seconds elapsed from the flagman's signal to the tail of the maximum load of sixteen skips passing off on the other side. There was an average of 100 trains a day, and despite the heavy road traffic there were no accidents or other disturbing incident. It may incidentally be remarked that a large number of trees, including twenty large elms, had to be removed. They were pulled down mechanically and at once cut up by power-driven saws.

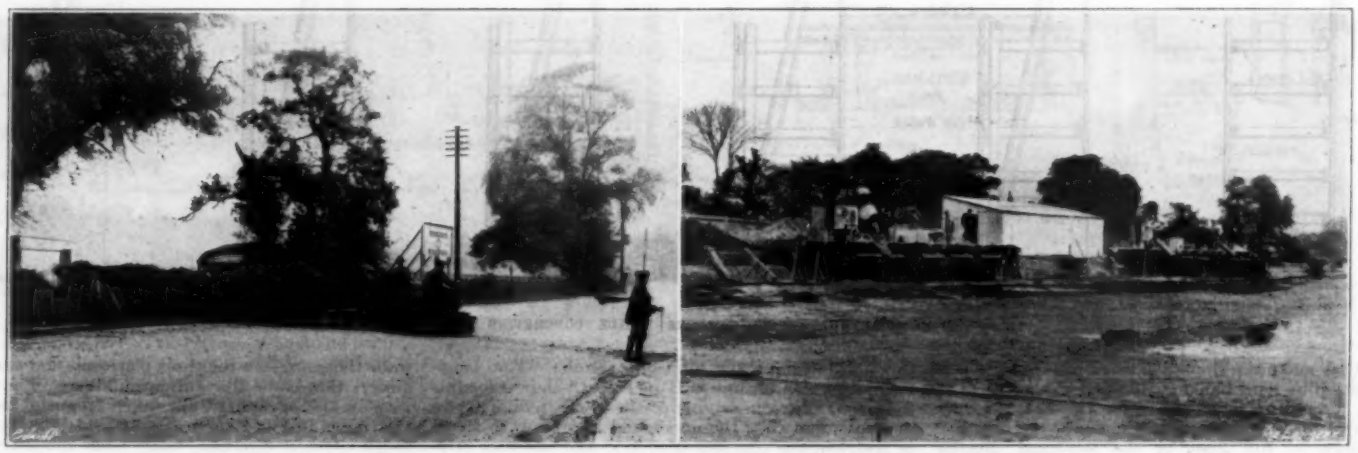


FIG. 25—EARTH TRAIN CROSSING LONDON-EPSOM ROAD

FIG. 26—UNLOADING BANK AND CONCRETE MIXERS

After the ground had been cleared, the same organisation took charge of the laying-out of the yard and the building of the car shed, which was begun on the east side and spread in a westwards direction, each detail, whether it was the ashes for the yard, the floor or walls of the car shed, the examination pits or the laying of the track, being finished from east to west. The 2ft. gauge track that had been used for removing the earth was employed for carrying the 7000 cubic yards of concrete from the concrete mixers to the site of the shed, and the 20,000 cubic yards of ashes to various points in the yard where they would be spread. The materials for the concrete and the ashes came by road, and were unloaded on a loading dock made in the south-west corner of the yard by a portion of the original earthwork being left in at about 6ft. above the level of the yard. On that, as seen in Fig. 26, a cement shed was built and three concrete mixers erected. The concrete was passed into the skips and conveyed to the site of the car shed. Some good organisation was necessary in that relation, as if the concrete was over 15 minutes in the skip it would set and would not pour. There had therefore to be plenty of skips handy, locomotive power and a clear road. The ashes came from Lots-road power house by lorry and were tilted on to a heap which made its own loading stage, whence, from a height of about 6ft. above the level of the yard, they were loaded into skips on the 2ft. gauge track.

The main road passes on the west side of the yard, and off it, in the south-west corner, a road has been made. The materials for the building and equipment of the shed came by road, and were unloaded on the site of the shed. The permanent tracks in the shed were laid in at an early stage, and they allowed for the quick distribution of the material by bogie. It is interesting to note that the track for one-half of the extension was assembled in the yard at Morden. About 8000 jarrah sleepers were cut to length and bored there, and had their chairs placed in position and screwed on.

The shed is 425ft. long by 300ft. wide with an extension in the south-west corner, 132ft. long by 120ft. wide. The main building is of five bays of 60ft. each, and the extension is of two bays of 60ft. each. The columns supporting the roof are placed at 28ft. 4½in. centres. There are twenty roads in the main shed, which will accommodate 140 cars. One bay in the extension is for an overhauling shop, is equipped with overhead cranes, and holds four cars. Outside, on the east side, are five storage sidings which accommodate forty-one cars and on the west side are seven sidings which hold fifty-five cars.

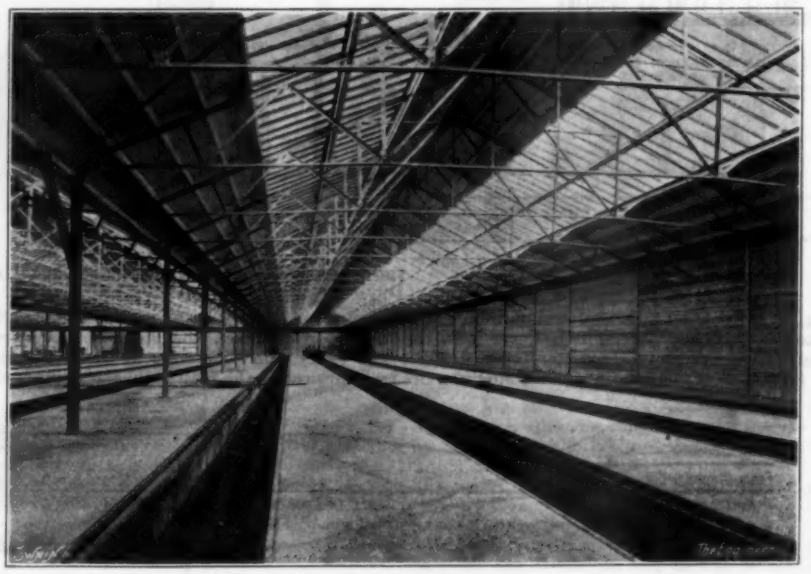


FIG. 27—INTERIOR OF CAR SHED, PARTLY COMPLETED

The extension also holds the stores and a mess-

room for the staff, which latter has lockers and a drying-room for the men's use. There is a vacuum cleaning plant between the stores and the main shed whence pipes are laid all over the shed.

Each road in the shed is pitted—as seen in Fig. 27—for a length of 385ft., with electric lights at intervals in the walls of the pit, and with tappings for the vacuum cleaning of the cars at every 60ft. The floor of the pit is at two levels; the lower level is in the centre, with the two sides of the floor at a higher and more convenient level. The walls of the pit are built to within about 1ft. of floor level, and on the top wooden blocks are laid which carry a flat-bottomed rail secured by rag bolts let into the concrete of the wall, the blocks and rails being subsequently concreted in.

The pipes for the vacuum cleaning, a 6in. fire main, &c., were laid under the floor of the shed as it was being made, and were concreted in. There are nine fire hydrants in various parts of the building. Hand-worked roller shutters close the entrances at the station end. An overhead conductor rail between each pair of roads furnishes power to move the cars when in the shed. The electrical connection is made by a jack coupling.

The permanent way connections giving access to the shed have been so arranged that a derailment at the points would cause a minimum of inconvenience. Besides a main road to and a main road from the shed there is a shunting neck on each side of the yard, which allows for shunting to be carried on with little inconvenience to arriving and departing trains. By a scissors cross-over road cars can run direct into any road, and can similarly depart. The points of the scissors cross-over and of the two shunting necks are coupled to a mechanically operated ground signal-box in the yard which contains six levers, of which two are spare. As there is a right-of-way for foot passengers across the ground now covered by the siding, a long footbridge, in reinforced concrete, is to be built.

We would repeat that the whole of the scheme for the Morden depôt, the design of the shed, lay-out of the yard, and all the construction have been executed by the railway company's own forces.

Iron and Steel Institute.

No. II.*

SIR PETER RYLANDS occupied the chair when the Conference reassembled for the reading and discussion of papers in the Palace of the Nobility on August 28th.

Professor Carl Benedicks then presented a paper by himself, Mr. H. Bäckström and Mr. P. Sederholm, dealing with "Anomalies in Heat Conduction with Some Determinations of Thermal Conductivity in Iron and Carbon Steels."

The authors' summary of this paper is printed below:—

HEAT CONDUCTION IN SPHERICAL STEEL SPECIMENS.

1. A method is described for the determination of thermal conductivity λ, in which a cylindrical specimen is heated electrically at one end and cooled at the other: in order to eliminate external heat losses a guard tube is provided, which is heated—or should be heated—separately to exactly the same linear temperature distribution.

2. After having been tested in several directions, this method was used for determining λ in the carbon steel specimens which had been previously investigated by C. Benedicks. Afterwards, a certain correction was applied for a persistent one-sided heat loss; for this purpose the method was improved by adopting a symmetrical arrangement.

3. For the sake of comparison, the electrical resistivity σ was determined; a survey is given of the changes in σ of hardened specimens, occurring during a period of twenty-six years.

4. As a first approximation, a fairly close connection between thermal ($1/\lambda$) and electrical (σ) resistivity was found to exist, though not corresponding with a constant Wiedemann-Franz product $\lambda\,\sigma$.

5. In accordance with this, the thermal resistivity of carbon steel may be expressed by the formula—

$$1/\lambda = 4{\cdot}4 + 8{\cdot}7\,\Sigma\,C,$$

where λ is expressed in cal./cm. sec. Grade and ΣC = carbon value in weight per cent. of added elements dissolved in the iron.

6. This formula assigns to pure iron ($\Sigma C = 0$) the value

$$\lambda = 1/4{\cdot}4 = 0{\cdot}227 \text{ cal./cm. sec. Grade,}$$

which hitherto has not been obtained. At all events, the purest iron tested (0·08 per cent. carbon) gave as high a value as 0·187, which ought to replace the value sometimes given for pure iron, $\lambda = 0{\cdot}135$.

7. It was attempted, as a better approximation than that given by the formula, to discuss the individual influences exerted by some added elements. In spite of the scarcity of available data, it seems justifiable, regarding their influence on λ, to range the added dissolved elements in the following order (mainly due to E. Sedström): nickel, manganese, hardening carbon, aluminium, silicon, indicating that the thermal conductivity of iron is lowered least by 1 atomic per cent. of nickel, more by manganese, and so on. Cementite carbon exerts only a slight influence on λ.

8. As pointed out in Part I. of this paper, too much importance should not be attached to λ figures, as the property designated thermal conductivity is apparently a complex one, not independent of the dimensions of the specimens used.

Professor C. H. Desch congratulated the authors on the work described, which was of remarkable interest, both from the practical point of view, as well as from that of the theory of conduction. It was, however, a matter which would have to be thrashed out very thoroughly by physicists before an adequate explanation of the remarkable facts could be devised. Professor Benedicks had referred to the irregularities of distribution which had been found, but it was not quite clear whether on repeating the tests on the same specimens the irregularities were also repeated in the original form, and if the ellipse showing the conductivity in different directions always had its major axis in the same direction.

Professor Benedicks intimated that such was the case.

Professor Desch, continuing, said that convection currents were set up by very slight irregularities, and their particular distribution seemed to be almost a chance. The mechanism of thermal conduction was much more complicated than that of electrical conduction, and even the phenomena of the latter form of conduction were not fully understood and were a subject of controversy among physicists. It would only be possible to make practical application of the results set out by changing the value of the coefficient of thermal conductivity. What had been disclosed in the paper would not, of course, affect the heat flow through a large mass like a boiler. Broadly speaking, it could be said that as the heat flow in any particular case could be determined by experiment, the practical consequence of the new views put forward would not be very great. With regard to the effect on the tendency to corrosion, there would be local irregularities of temperature, but they could be measured. Cylinders gave much more uniform results than spheres, and plates should be even more equal in behaviour, and in such cases the corrosive influences would be negligible. In conclusion, he desired to pay testimony to the great skill which had been shown in devising apparatus which had led to the beautiful research, some of the results of which were now disclosed.

Dr. W. H. Hatfield said that those engaged in the metal industries were much indebted to Professor Benedicks for the researches dealing with physical constants of which he had given the results from time to time. Referring to the contribution then made, which was an extremely valuable one, he did not think there was any need for anxiety because discrepancies were revealed, as when that happened during careful investigations, it suggested that something of consequence was going to be discovered. The idea had been advanced that a possible explanation of some of the facts was heterogeneity of the steel. He could not accept that theory. As an illustration of the conditions under which the work described had been done, he might mention that if it were necessary to obtain accurate determinations, Professor Benedicks could have the traffic in Stockholm held up whilst his observations were made. Referring to the figure ·187 given for thermal conductivity, that was rather high when compared with the value of ·142 obtained by Ingersoll and his co-workers, and the figures of ·151 and ·143 of Jaeger and Deisselhoert. It was important that closer agreement should be reached by investigators who were working out the physical constants. Speaking from the point of view of a steel works metallurgist, he hoped work of the kind would be continued, so that definite knowledge of the physical constants of materials could be placed at the disposal of those engaged in industry.

Dr. Arthur Bramley said he assumed that in the spherical method of experimenting, in which the spheres had been turned and then cut in two, the plane section bore some definite relationship to the direction of rolling. He would like to know whether spheres had been made in which one section was transverse to the direction of rolling, and another at right angles to it. If that were so, could Professor Benedicks state whether this difference in the character of the sections affected the conductivity. A few years ago Professor Callendar had carried out some most interesting experiments on conductivity with cylindrical tubes. That method worked exceedingly well for materials of low conductivity, but was associated with considerable difficulty in the case of the other materials.

Professor Benedicks, in a short answer to the discussion, said with regard to the point raised by Professor Desch, that when the experiments were repeated the results obtained were the same. The boiler material employed was that ordinarily used in the construction of Swedish boilers, and it was not an easy matter to get a determination which could be accepted as reliable. Consideration had been given to the possibility of obtaining direct evidence of temperature differences, and an experiment which he believed would give a delicate measurement was now in course of preparation. With regard to Dr. Hatfield's remark, it was not claimed that the figure for thermal conductivity given in the paper was the true value. Great care had been taken to obtain an accurate determination, but the task was very difficult. Dr. Bramley had asked if experiments had been made with sections taken at right angles as well as transverse to the direction of rolling. That had been done. It had been expected that very regular results would be obtained when the plane of the hemisphere was at right angles to the axis of the cylinder. That expectation was not realised.

Mr. E. H. Saniter suggested that different results might have been obtained if the spheres had been cast instead of being rolled.

The authors were very warmly thanked for what the President described as a fine piece of work.

Professor Roos presented a paper by Axel Lundgren, of the Government Testing Institute, on "The Testing of Hardened Steel."

TESTING OF HARDENED STEEL.

For testing the mechanical properties of hardened steel in those respects which are important for the practical use of steel, there has been elaborated a testing system, including bending tests, determination of limits of proportionality, elasticity, and ultimate strength, as well as impact and hardness tests.

Four kinds of carbon steel with 1·3, 1·0, 0·9, and 0·6 per cent. carbon have been subjected to comparative tests after hardening and tempering at various temperatures.

Two of the steels, with carbon 1·3 and 1·0 per cent., were, prior to hardening, also subjected to various annealing treatments for bringing about various structural forms.

From the series of tests carried out results were obtained, of which some are already known from practical experience. Others, however, have been obtained which might be difficult and tedious to discover definitely merely by practical tests.

Of the results obtained the following may be referred to:—

1. The steels with 1·3 and 1·0 per cent. of carbon respectively annealed in such a manner that the cementite was developed in a fine-grained form, show, with subsequent hardening and tempering, a higher bending strength and a higher impact resistance than specimens which, before hardening, have been annealed so that more coarse-grained cementite has developed.

Specimens in which all the cementite is spheroidised show, after hardening, higher bending strength and impact resistance than those which have a coarse network of surplus cementite.

Specimens with a finer network of surplus cementite show a higher bending strength and impact resistance than specimens with a coarser network.

2. Steel with the highest percentage of carbon of those tested (carbon 1·3 per cent.), using the three quenching temperatures 765 deg., 790 deg., and 815 deg. Cent. and tempering at 150 deg. and 200 deg. Cent., shows a higher bending strength than the other steels tested.

Steel with carbon 0·9 per cent., at all quenching temperatures and with tempering up to 280 deg. Cent., shows the lowest bending strength of all the steels tested.

Specimens of steel with carbon 1·3 and 1·0 per cent., after annealing so that fine-grained cementite has developed (annealing method *B*) show, at all hardening temperatures and tempering temperatures (with a certain exception) up to 280 deg. Cent., a higher bending strength than the unannealed ones.

With increased quenching temperature all the steels tempered at 150 deg. and 200 deg. Cent. show a reduced bending strength. This is the case in a higher degree with steels tempered at 150 deg. than with those tempered at 200 deg. Cent.

With increased tempering temperature the steels become, with regard to bending strength, less susceptible to the raising of the quenching temperature. With tempering at 400 deg. Cent. an increase of the quenching temperature from 765 deg. to 815 deg. Cent. has very little effect.

3. Steel with 1·3 per cent. carbon at low tempering temperatures, 150 deg. and 200 deg. Cent., has on an average a somewhat higher impact resistance than a steel with 1·0 per cent. carbon. Steel with 0·6 per cent. carbon possesses, at all quenching temperatures used, and 150 deg. Cent. tempering, approximately the same impact resistance as the steel with 1·3 per cent. carbon. With 200 deg. Cent. tempering and beyond steel with 0·6 per cent. carbon possesses a higher impact resistance than the other steels tested.

Steel with 0·9 per cent. carbon has, at all quenching temperatures used and tempering temperatures up to 280 deg. Cent., a lower impact resistance than all the other steels tested. By raising the quenching temperature the impact resistance is reduced when tempering up to 280 deg. Cent. With a higher tempering temperature (below 280 deg. Cent.) a certain increase in the quenching temperature reduces the impact resistance more than in the case of lower tempering.

4. With regard to hardness, a great difference is apparent between, on the one hand, the steels with 1·3, 1·0, and 0·9 per cent. carbon, and, on the other, the steel with 0·6 per cent. carbon, inasmuch as the last-mentioned possesses considerably less hardness than the others. Between the three first-mentioned no great difference was obtained. The average figures for several tests nevertheless show the greatest hardness for steel with 1·3 per cent. carbon, and the smallest for steel with 0·9 per cent. carbon. Likewise a slightly greater hardness has been obtained for the specimens unannealed before hardening than for the annealed specimens of steel with 1·3 and 1·0 per cent. carbon.

When examining the relation between hardness, bending strength, and impact resistance at 765 deg. Cent. quenching temperature, it will be seen that with the highest hardnesses steel with 1·3 per cent. carbon possesses a greater bending strength and impact resistance than the other steels. With lower hardnesses all show approximately the same bending strength. The impact resistance, above a certain hardness, is greatest for steel with 1·3 per cent. carbon, after which steel with 1·0 per cent. carbon possesses the greatest impact resistance up to a certain hardness. For specimens with lower hardness no trustworthy testing results have been obtained.

5. The influence of the rate of cooling upon the ultimate bending stress after tempering has been tested with a tempering temperature of 300 deg. Cent. In this connection it has been found that, in the case of very rapid cooling in benzene a much lower bending strength was obtained than in the case of a less rapid cooling in air.

Dr. A. Bramley asked if the author had made any experiments where the duration of the tempering process had been varied. He raised this point because a study of the tables given in the paper suggested that the duration of the tempering process, as well as the quenching, must have some effect.

Dr. W. H. Hatfield commented on the lack of full information as to the nature of the steels employed. Reference was made to four kinds of steel, meaning four kinds of carbon steel; but it would be interesting to know the history of the steel and the metallurgical processes which had been employed. It would also increase the value of a research of the character described in the paper if it could be extended to cover steels made by different processes to determine if there were any intrinsic characteristics in the materials which were not readily disclosed by simple quantitative tests. The author mentioned the need for putting the steel into a globular condition before hardening and tempering.

Mr. Lundgren will reply to the discussion by correspondence.

In the absence of the authors, a paper contributed on behalf of the National Physical Laboratory by Mr. G. A. Hankins, Dr. D. Hanson and Miss G. W. Ford, was brought up for discussion. This paper dealt with the mechanical properties of heat-treated spring steels.

HEAT-TREATED SPRING STEELS.

The investigation described in this paper has been undertaken at the National Physical Laboratory as part of a systematic investigation of the mechanical properties of steels commonly

* No. I. appeared September 3rd.

used in spring manufacture which forms part of the programme of the Springs Committee. The steels investigated are those most frequently used in the manufacture of laminated springs, and the material was therefore obtained mainly in the form of flat plates 3in. by ¼in. in section. The tests have been devised with a view to disclosing the mechanical properties of the materials, and the test pieces have been prepared in such a manner as to eliminate, as far as possible, variations due to surface blemishes, decarburisation, or other disturbing factors. At a later stage in the investigation a determination of the properties of these materials in the form of complete springs will be necessary: in connection with these latter tests the results described in the present paper are of fundamental importance. The materials consist of two straight carbon steels containing 0·6 and 0·8 per cent. of carbon respectively, a silico-manganese and a chrome-vanadium spring steel, and all are typical high-grade steels supplied by leading firms of steel makers. The main points which the tests appear to have brought out are given below.

0·6 *Per Cent. Carbon Steel.*—It is unusual to adopt oil quenching on a material of this composition, but probably for this reason the results are of considerable interest. The quenching temperature required for complete hardening is high, but the test results are good for a carbon steel. The elongation and reduction of area are lower than for the other steels of similar hardness and tensile strength, but the fatigue limits, while somewhat lower than the other steels between 350 and 430 Brinell number, are not unduly low. At a Brinell number of 450 the fatigue limit is as high as ± 47 tons per square inch, against ± 43·5 for the chrome-vanadium steel and ± 50 for the water-quenched silico-manganese steel. The corresponding elongation and Izod values are inferior to the alloy steels. The Izod values of the steel at the higher tempering temperatures (and correspondingly lower Brinell numbers) are as good as the values given by the silico-manganese steel.

0·8 *Per cent. Carbon Steel.*—This steel could not be properly hardened in oil even by quenching from 950 deg. Cent., and hence the effect of tempering, up to 500 deg. Cent. is very small. Tempering at 550 deg. Cent. gives a reduction in hardness accompanied by an increase in ductility and a decrease in tensile strength and fatigue limit, but the Izod value is not improved. The limits of proportionality both in tension and torsion are distinctly low, but the fatigue limits are not inferior to the other steels of the same hardness. The results do not show any marked differences in mechanical properties for the two quenching temperatures, but the higher temperature (900 deg. Cent.) produces more uniform material than the lower temperature (830 deg. Cent.).

Silico-manganese Steel.—With this steel the distinct change in the slope of the Brinell number tempering temperature curve does not occur until a temperature of 400 deg. Cent. is reached, compared with 250 deg. Cent. for the chrome-vanadium steel, and 300 deg. Cent. for the 0·6 per cent. carbon steel. Above this temperature the rate of decrease of hardness is more rapid for the silico-manganese than for the other steels. The water-quenched material gives high values for the tensile limit of proportionality at the three higher tempering temperatures, and a similar result is also apparent in the torsion tests. Values of elongation and reduction of area are fairly good in all the tests on both oil and water-quenched material, while the Izod values are not particularly low. The fatigue limits at the three lower tempering temperatures for either oil or water-quenched material are superior to the other steels. In general, the water-quenched material appears to be slightly superior to the oil-quenched material. It should be noted that the fatigue results on individual specimens of the steel, oil quenched from 950 deg. Cent. and tempered at 600 deg. Cent. are somewhat irregular, and it is possible that the value obtained (± 36 tons per square inch) is somewhat lower than would be obtained in a repeat test.

Chrome-vanadium Steel.—It is apparent from the results that the ultimate tensile and torsion strengths are low for this material when compared with corresponding Brinell numbers. It is fairly definite, however, that, with the exception of tempering at 600 deg. Cent., the chrome-vanadium steel has lower values of fatigue limits than silico-manganese steel of similar tensile strengths or tempereed at similar temperatures. The Izod values, however, are distinctly superior to all the other steels. Chrome-vanadium steel, tempered at 600 deg. Cent. (giving a Brinell number of 400), combines a high Izod value and good reduction of area, with a fatigue limit of ± 42·5 tons per square inch.

Dr. Hatfield, who briefly introduced the paper, said he was a member of the Springs Research Committee, for whom the work was done. The research dealt with steels used in the manufacture of laminated springs. Two varieties of carbon steel having ·6 and ·8 per cent. carbon and manganese and chrome vanadium steels were supplied for the experiments. One fact which should be noted was that the steels were studied on their own merits, apart altogether from the effect of the heat treatment current in the spring section of the steel industry.

Mr. E. H. Saniter drew attention to the table on page 2 of the paper, and inquired how the steels included in that list were made. They were not steels which could be considered representative of those used in the spring industry in Great Britain. They were of such remarkable purity that he ventured to question the accuracy of the analyses. He had no experience of British steels containing less than ·021 of sulphur, but the chrome vanadium steels referred to in the paper were said to contain only a trace of sulphur. On a point of practice, he noticed it was stated that in order to get the carbon steels to harden in oil they were quenched at over 950 deg. Cent., which was not done by spring manufacturers. In workshop practice the material would not in any case be heated up to 950 deg. He would like to know what kind of oil was used for quenching, as the result obtained would very definitely be affected by the viscosity of the oil. In another table, printed on page 11 of the paper, he noted some extraordinary discrepancies in the hardening results obtained with the cabon steels, and it was difficult to understand why the ·8 per cent. carbon steel would not harden properly. A remarkable figure for tensile strength was given for the ·6 per cent. carbon steel when quenched at 950 deg. and tempered at 400 deg.

Mr. C. E. Stromeyer raised the question of fatigue tests. The experiments appeared to confirm practice in showing that springs should not be stressed to the limits of proportionality. He had plotted the results given on his own system of fatigue testing, and he found that there was some variation in the results. By his method the endurance limits worked out at about two-thirds of the limit of proportionality, which was in agreement with practical experience. His figures for the chrome vanadium steels were much below those given by the authors of the paper; his value was 39 tons, while their figure was 45 tons, and the ratio between the endurance limit and the limit of proportionality was therefore smaller than two-thirds.

Mr. A. Hultgren welcomed this contribution, but looked forward with more interest to the paper which was promised on steels from actual springs. These further tests should throw light on the problems of heat treatment.

Dr. Hatfield, who dealt on behalf of the authors with one or two of the points referred to in the discussion, said that Mr. Saniter had commented on the purity of the steels, and he was able to state that although the material was specially prepared, manufacturers of electric steel were able to supply steels of this high quality. The explanation why the ·8 per cent. carbon steel did not harden would appear to be the low manganese content, which was ·3, instead of ·8 per cent. The authors would, he was sure, be grateful to Mr. Stromeyer for plotting out the fatigue values. He agreed that some of the temperatures employed were very high, but the authors were justified in a research of the character in exploring a new field and endeavouring to ascertain if industrial practice could be improved.

Professor Carl Benedicks congratulated the authors on what he regarded as an investigation on a subject of practical interest. The work had been done with very great care.

The last paper to be brought before the meeting for discussion was one by Professor A. Johansson and Mr. R. von Seth, of the Royal Technical University, Stockholm, on "The Carburisation and Decarburisation of Iron and Some Investigations on the Surface Decarburisation of Steel."

The following summary is given in the paper:—

DECARBURISATION OF IRON.

1. The equilibria of the reaction $3Fe + 2CO \rightleftarrows Fe_3C + CO_2$ have been determined between 700 deg. and 1100 deg. Cent. At 700 deg. the equilibria coincide with those of Schenck, but Schenck's theories on the equilibria above 700 deg. Cent. have not been confirmed. The theoretical bearing of the equilibria found is briefly mentioned.

2. The equilibria of the reaction $Fe_3C + 2H_2 \rightleftarrows 3Fe + CH_4$ have been diagrammatically presented, likewise a series of experiments have been carried out on the decarburising action of pure dry hydrogen.

3. In pure nitrogen at 1050 deg. Cent. no decarburisation has been found other than that presumably depending on the influence of gases as well as oxides in the steel. No formation of cyanogen has been established.

4. A series of experiments has been carried out on the surface decarburisation of steel between 650 deg. and 1100 deg. Cent., on heating in different gas mixtures, consisting of carbon dioxide and carbon monoxide as well as in pure air. The results obtained are briefly discussed.

Professor Benedicks commented on the manner in which most metallurgists had avoided dealing with questions of equilibrium, in spite of the importance of the subject. One reason was that the diagrams submitted by earlier workers were of so complicated a character and so difficult to understand that the task involved seemed to be of an appalling character. He thought it could be claimed, however, that this paper marked a new departure in dealing with this question, the results attained being shown in a most lucid manner. It was a remarkable contribution to a most difficult subject.

Dr. A. McCance congratulated the authors very warmly on the admirable manner in which they had overcome the difficulties of the task undertaken. Not only was the experimental work difficult, but also the interpretation of the results. At a later date he would offer one or two alternative explanations on some points. He noted in passing the upward tendency of the curve relating to the decarburisation in one instance with the lowering of the carbon content. It would seem that the curve should be horizontal, and he suggested that there was perhaps an alternative reaction which would explain the upward trend of the curve. Carburisation might take place from the absorbed oxide in the steel. At all events, what took place might be susceptible of simpler explanation than that given.

Professor Johansson intimated that he would deal with some aspects of the question at issue by correspondence.

This concluded the programme of papers and discussions.

VOTE OF THANKS.

The President then moved, and the meeting carried by acclamation, a vote of thanks to the Swedish Ironmasters' Association, the owners of mines and works, and all other organisations and individuals who had been associated with the organisation of the Stockholm meeting, which had up to that point, and would he did not doubt be until the end, a conspicuous success.

BANQUET AT CITY HALL.

A banquet, which was given by the President and the City Council in the famous City Hall of Stockholm on the evening of August 28th, will be long remembered by those who had the good fortune to be present. The building is, of course, a most notable example of civic architecture of which Stockholm is justly proud. Although the hall was only recently completed, the plans for a civic headquarters worthy of Stockholm were under consideration as long ago as the year 1908. The selection of the site immediately opposite the old "city within the bridges," on the cape which pushes out between Riddarfjarden and Klaraviken, was admirably designed to emphasise the maritime character of Stockholm. The architect, Ragnar Ostberg, seized with a touch of real genius, has given to Stockholm a City Hall which many affirm has no superior in Europe, and can challenge comparison with anything the world can show. The open court of the Hall, the Civic Court and the noble covered court, known as the Blue Hall, constitute, in conjunction with the Southern Arcade and the Waterside Terrace along the bank of the lake, features which command admiration. Red brickwork, chiselled out after being put in position, has been employed with striking effect for the wall surfaces. The Great Tower rises to a height of 106 m. above water level. The meeting halls and rooms are numerous, but conspicuous among them are the Great Session Chamber, the Council Chamber, the State Apartments and the Golden Chamber.

It was in the latter that Mr. Allan Cederborg, the President of the Council, presided over the distinguished gathering met to do honour to the Iron and Steel Institute. The Chamber itself, 44 m. long, 14 m. broad and 12 m. high, is a wonderful piece of work. Both the large pattern floor paving and the dado are in Kolmanden marble. The walls are entirely covered with gold mosaic work and designed to illustrate the history of the city and its industries, commerce and handicrafts. The ceiling, which consists of the actual beams used in building, is of exposed cement treated in colour.

A number of speeches were delivered at the banquet, in which stress was laid on the happy relations existing between Sweden and Great Britain. Sir Hugh Bell, who was most warmly received, made a thoughtful contribution to the economics of industry and trade, and an admirable address was given by the President of the City Council. He said that members of the Institute were assured of a warm welcome in Sweden, where the iron industry had been established for so long. In the early Middle Ages almost every yeoman in the maritime provinces of Sweden had his own mine, and worked it and sold his ore. These individual enterprises were at a later date merged into the form of associations and companies. The early mining and metallurgical interests represented some of the best elements in the Swedish nation. At a later date when it became necessary to form an association for the protection of mutual interests, Jernkontores came into existence. Technical progress had changed conditions in the iron trade. At the present time after-war depression had perhaps laid its heaviest burden on the iron industry, and it was more than ever necessary for those engaged in it all over the world to utilise chances of improving and cheapening their products. The Iron and Steel Institute had for nearly six decades given attention to the development of technical practice and the advance of iron and steel metallurgy. The Royal charter of the Institute affirmed that it had most efficiently and successfully contributed to the material prosperity of Great Britain, and it was also acknowledged that its work had in some ways benefited the whole world. It was with sincere pleasure that the representatives of Stockholm welcomed members to their city.

Sunday, August 29th, was devoted to an excursion by steamer among the islands, on the invitation of Mr. Axel S. W. Odelberg, and the porcelain works of which he is managing director, which are situated at Gustafsberg, were inspected.

On Sunday evening two parties left for visits of inspection to mines and iron and steel works in Central Sweden.

The High-pressure Turbine Steamer King George V.

No. I.

On Tuesday last, September 7th, the new high-pressure geared-turbine steamer King George V. ran a demonstration trial on the Firth of Clyde, prior to her taking up for the remainder of the tourist season the regular Clyde passenger service of her owner managers, John Williamson and Co., of Glasgow. The King George V. is the fourth turbine-propelled steamer to be built to the order of Turbine Steamers, Ltd. Like her predecessors, she has been constructed by William Denny and Brothers, Ltd., at Dumbarton, and has been engined by the Parsons Marine Steam Turbine Company, Ltd., of Wallsend. The occasion of her recent trial was, however, most noteworthy because she is the first ship to be fitted with high-pressure steam turbine machinery, while her boilers represent the newest marine practice. They have been designed and built by Yarrow and Co., Ltd., of Scotstoun, Glasgow, for a normal working pressure of 550 lb. per square inch, and a total superheated steam temperature of 750 deg. Fah.

INTRODUCTORY.

The early days of the passenger steamer on the river Clyde and its development through the eventful years of the nineteenth century presents a fascinating field of study to those interested in the history of marine engineering. In the period—almost a century

—which intervened between the building of the first steamship on the Clyde, the Comet, of 1812, and the first passenger turbine steamer, the King Edward, of 1901, over three hundred steamers of various types, mostly paddle steamers, were built for the Clyde service. In our present article it is not our intention to refer to the gradual development of the propelling machinery of these ships from the half side-lever engines of the Comet, by way of oscillating and steeple engines to the well constructed diagonal condensing engines of the late nineties, which to-day are doing excellent service on the Firth. In passing it may be remarked that these ships embodied important pioneer work, both on hulls, machinery and boilers, which has contributed no small part to passenger ship design and development. The ships of these years are described and illustrated in the late Captain James Williamson's informative and pleasing book, "The Clyde Passenger Steamer," * unfortunately now a somewhat rare volume.

Of the history of the turbine-propelled Clyde steamers, however, we have more to say. It is a little over a quarter of a century ago since the late Captain John Williamson, who was then the managing director of a syndicate formed by the owners and builders to test the suitability of the then new system of turbine propulsion for passenger ships, placed with William Denny and Brothers, Ltd., of Dumbarton, the order for the King Edward. At that time Clyde shipowners were looking for more speedy craft, but the essential quality of small draught in order to work the many shallow piers on the Firth of Clyde had hitherto confined the builders to the use of side paddles.

The small diameter high-revolution propellers of the Parsons system presented new and wide possibilities for such work, and the builders were quick in grasping the advantages of the new system. In the spring of 1901 the King Edward was laid down at Denny's Dumbarton yard, and she ran her measured mile trials on June 26th of that same year. She had an overall length of 250ft., with a breadth moulded of 30ft., a depth of 10ft. 6in., and a draught of 6ft. On the Skelmorlie mile a mean speed of 20·48 knots was recorded. Her machinery consists of a triple-screw arrangement of Parsons turbines, directly coupled to the propeller. The centre shaft on which the high-pressure turbine is placed is equipped with a 57in. diameter propeller, while the two side shafts, which are placed 9ft. apart, have 40in. propellers. They are driven by low-pressure turbines, working in parallel with the centre high-pressure turbine and on these two shafts reversing turbines are also fitted. The speed of the centre shaft is about 505 revolutions per minute, while the two side shafts run at 755 revolutions. The Clyde passenger service is somewhat expensive to run, and the owners of these ships prefer to use free-burning quick-steaming coal obtained locally. For this reason oil burning has not been considered for these steamers, and double-ended coal-fired boilers, designed for a working pressure of 150 lb. per square inch, are employed.

During her first season's run the King Edward established an average consumption of about 1·8 lb. of coal per equivalent indicated horse-power for the shaft horse-power developed, corresponding to about 8·87 knots per ton of coal used. The indicated horse-power was deduced from the model trials of the hull and assessed at about 3600.

So popular was this first turbine steamer that the following year a sister ship, the Queen Alexandra, was ordered from the same builders.

She is in all respects similar to her predecessor, but is slightly larger as regards her hull dimensions and machinery output. Her length is 270ft., with a breadth moulded of 32ft. and a depth of 11¼ft., whilst her turbines are designed for a sustained maximum speed of 21¼ knots, a figure easily obtained on her trial runs.

The turbine steamers referred to in this article are used for daylight excursion service on the Firth of Clyde and the adjacent Lochs. They carry about 2000 first and second-class passengers, and have cabin and fore-saloon accommodation. The main trips are made from Greenock and Gourock to Campbeltown and Inveraray, being return runs of approximately 118 to 126 miles. The steamers start from Greenock about 8.50 a.m. and return at 6.35 p.m. the same evening. In the summer months short evening cruises on the Firth form part of the programme. During the winter months the vessels are laid up over a period of from about the end of September till the beginning of May.

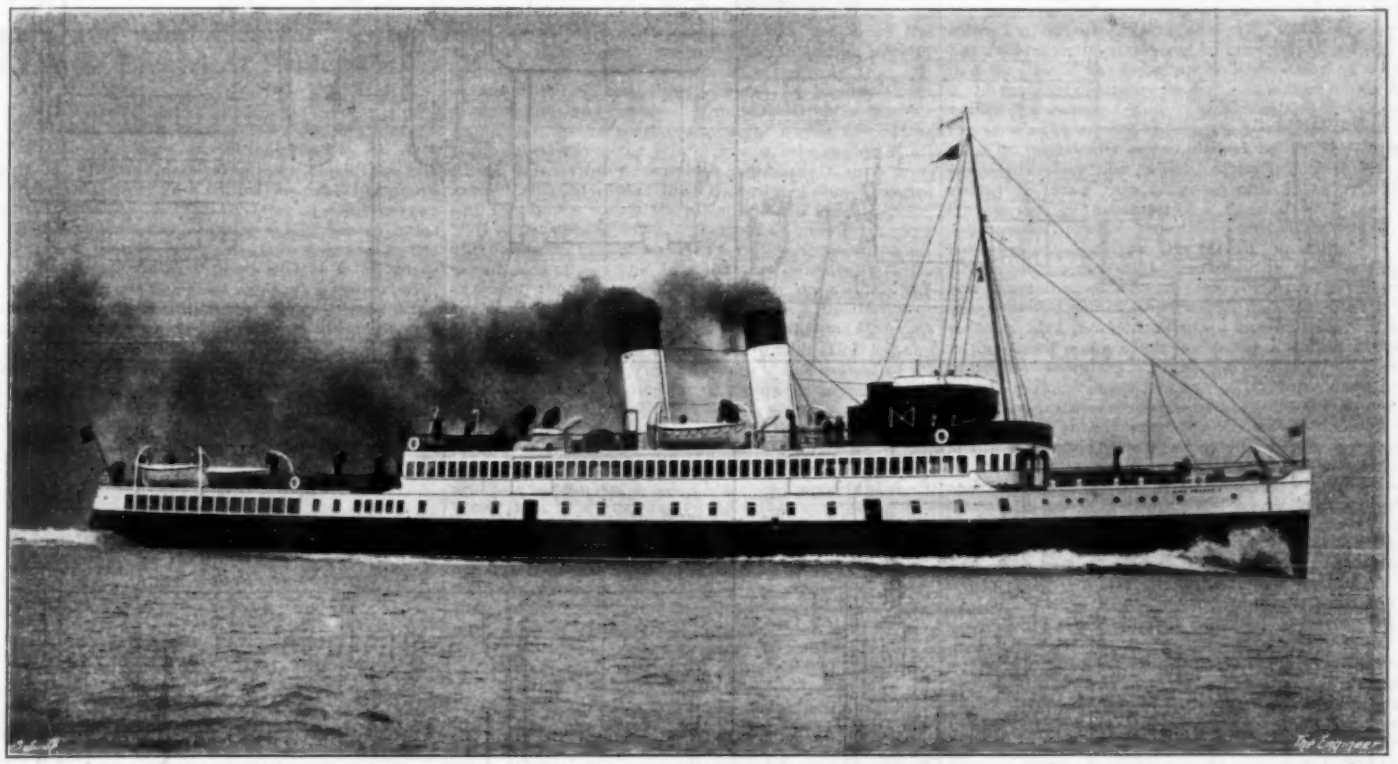
In the year 1912 the upper part of the Queen Alexandra was burned, and after reconditioning that vessel was sold to the Canadian Pacific Railway Company for Vancouver service. In the same year another steamer, the second Queen Alexandra, was built for the Clyde services. In the Great War these vessels did excellent work during 4¼ years, and more than 30,000 troops were carried on them; the King Edward, in particular, performed notable service in the Archangel Expedition.

Their early and marked success led to immediate and important developments in the application of the Parsons turbine to the propulsion of large passenger liners. In November, 1905, the Cunarder Carmania was completed by John Brown and Co. at Clydebank and fitted with triple-screw Parsons turbines of about 20,000 shaft horse-power and 180 lb. per square inch steam pressure. Not long after the famous Cunarders Mauretania and Lusitania followed with four-screw machinery of about 75,000 shaft horse-power and 195 lb. per square inch steam pressure. The first-named vessel still holds the "blue riband" of the Atlantic to-day. General turbine propulsion followed immediately on the direct type of machinery, and this class of turbine reached its zenith in the Brown-Curtis installation, built by John Brown and Co., Ltd., for the Cruiser Hood, 1919, which totalled 144,000 shaft horse-power, or 36,000 horse-power for each of four shafts.

Higher Steam Pressures.

Although there was a rapid increase in the power of the turbines built in the twenty years succeeding the King Edward, not much development in the direction of higher steam pressures and temperatures took place until after the war. This new direction of advance was largely influenced by the success of high-pressure land and power station practice, and by the increased confidence in the uniformity and heat-resisting properties of materials which were conferred by the more common use of steel and certain of the non-ferrous metals in boiler construction. It may also be said that the quality of workmanship has improved, and that with these advantageous factors there no longer remains any hindrance to the use of reasonably higher steam pressures and temperatures. The decision to build a Clyde turbine steamer equipped with high-pressure geared turbine machinery came a little over a year ago, as a reply by the steam engine to the advance made by the oil engine with its increased thermal efficiency. It was also rightly felt that any progress made in the direction of using coal for steam raising would rehabilitate one of our most important and basic industries. On the side of the turbine builder experience had already been accumulated from successfully operated high-pressure steam plants. Several power stations were being run without difficulty with steam pressures of over 400 lb. per square inch, while a total temperature of superheated steam up to, say, 400 and 500 deg. Fah. was known to both marine and land engineers. Perhaps the greatest factor in the direction of assured success for the marine application was the recent satisfactory full load performance of the 50,000 kilowatt generator set installed by C. A. Parsons and Co., Ltd., at the Crawford Avenue Station of the Commonwealth Edison Company of Chicago, which is supplied with steam at a pressure of 550 lb. and at a stop valve temperature of over 650 deg. Fah., with a reheat temperature of 700 deg. Fah. For the high-pressure marine boiler probably no better type exists than the water-tube pattern developed by Yarrow and Co., Ltd., which firm can build boilers for working pressures of 550 lb. up to over 1000 lb. per square inch. It is not surprising that even before the trials of the King George had taken place, the design of her machinery had already influenced in a remarkable way the application of high-pressure geared turbine machinery for the propulsion of large liners and cargo vessels.

We have in mind the recent orders which were placed on the Clyde and Tyne by Canadian Pacific Steamships, Ltd., for two passenger liners and five cargo ships, which will be fitted with high-pressure geared turbine machinery, designed for pressures of 350 lb. and 250 lb. per square inch respectively. The boilers will comprise a combined arrangement of Yarrow water-tube and Scotch boilers, and will be coal fired, mechanical stokers being fitted on all the cargo vessels.



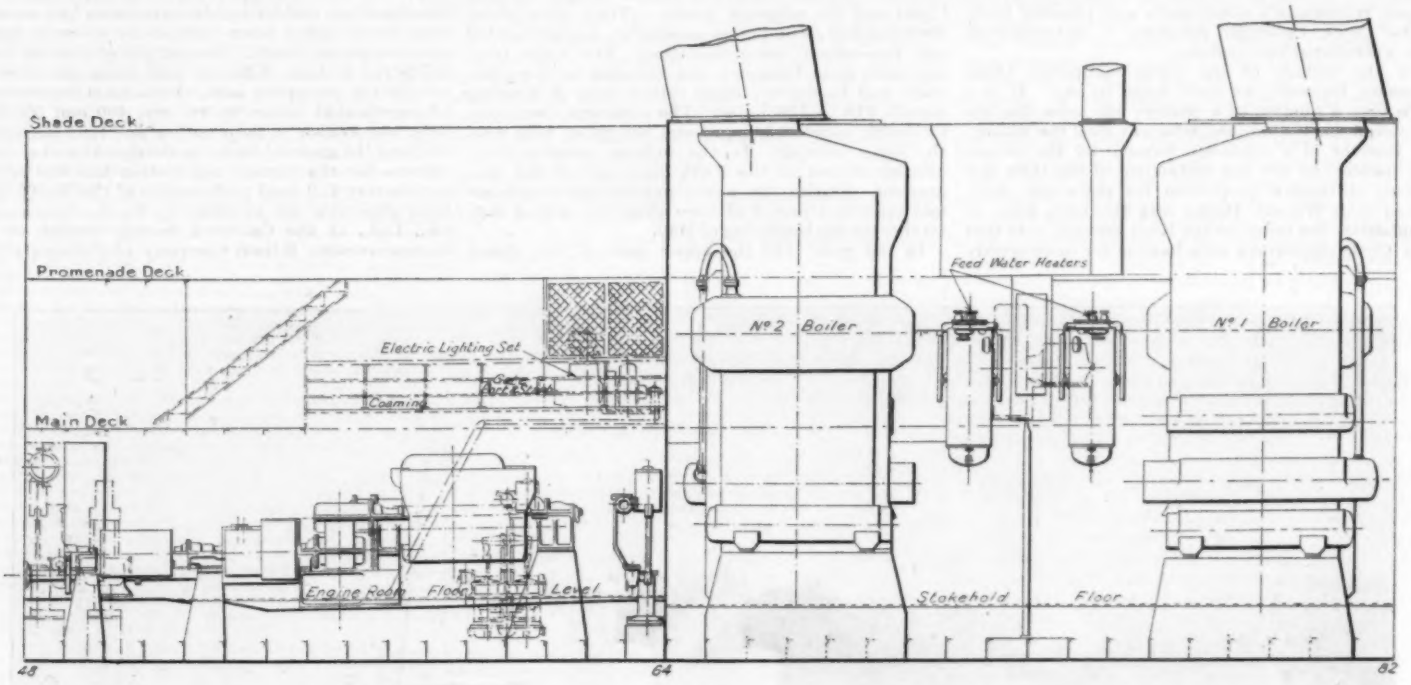
THE HIGH-PRESSURE GEARED TURBINE CLYDE STEAMER KING GEORGE V.

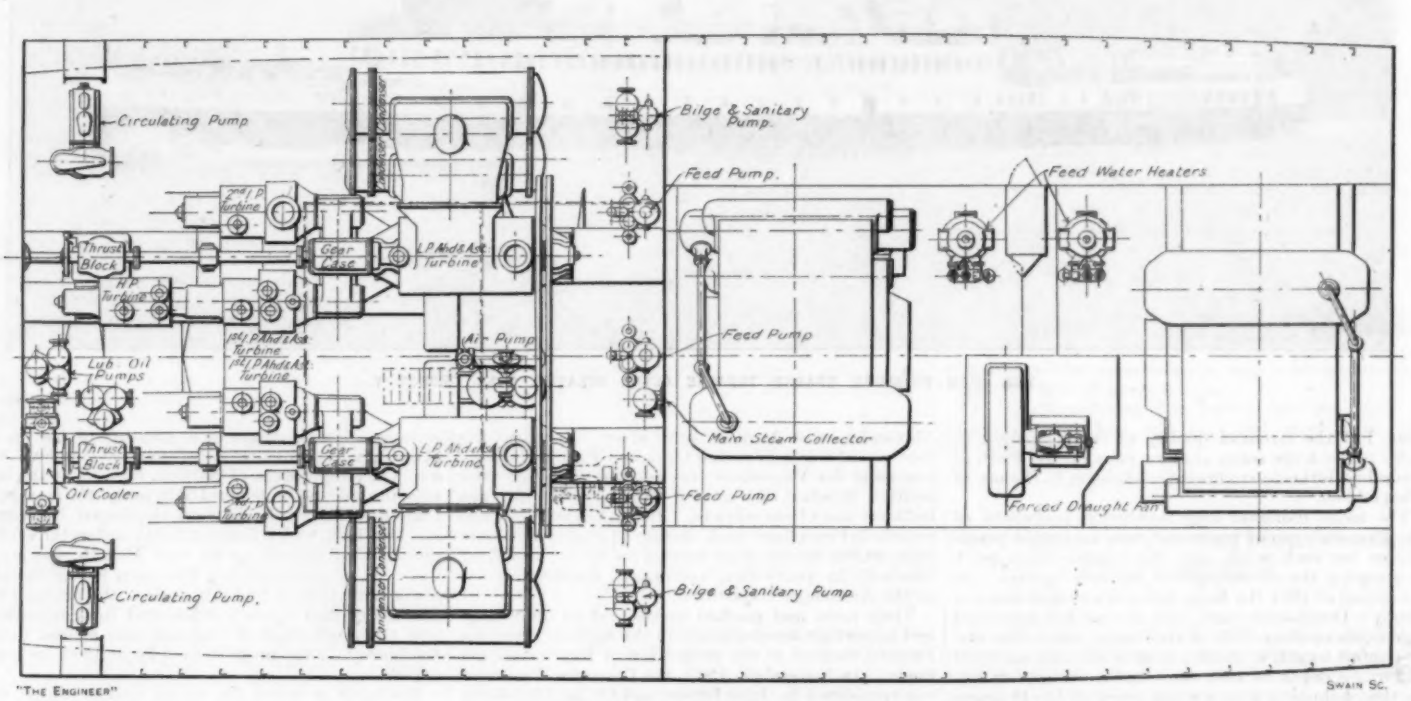
The New Turbine Steamer.

A photograph of the new high-pressure geared turbine steamer King George V., taken during one of her recent steaming trials in the Firth of Clyde, is reproduced above. We may remark that the Silesian coal which was then being used contributed largely to the smoke from her funnels, unfortunately a familiar feature of all Clyde steamers. She was ordered about a year ago, and in size is midway between her two sister ships, the King Edward and the Queen Alexandra. Her overall dimensions are as follows:—Length, 260ft.; breadth moulded, 32ft.;

* "The Clyde Passenger Steamer," by Captain James Williamson. James Maclehose & Sons, Glasgow. 1904.

depth moulded, 11ft.; with a draught of about 6ft. As regards her external appearance, although she has the usual two white, black-banded funnels of her line and one fore mast, she is readily to be distinguished from her sister ship by the closed-in sides, which run for the whole length of the accommodation between the promenade and shade decks. This practice, though an innovation on the Clyde, has been adopted with very great success on the Southern Railway cross-Channel boats Isle of Thanet and Maid of Kent, which were also constructed by Messrs. Denny. Speaking from our own experience, we should say that this new feature of the King George V. will render that ship the most popular vessel in her fleet, and will eventually lead to similar protection being provided on other Clyde vessels. The windows on the closed promenade deck are large and wide, and quite a number of them are arranged to open so that there can be no lack of fresh air on hot days. Generally, however, there is ample open deck space on the broad shade or boat deck, which is open to first-class passengers, and on the fore and aft open promenade decks available for second and first-class passengers respectively. Part of the enclosed promenade deck —namely, that forward with curved end windows —is allotted to second-class passengers, and incidentally we found this to be one of the most pleasant parts of the ship. For many years it has been general Clyde practice to place the main dining saloon on the lower deck aft. In the new ship this room is arranged aft, but at main deck level. It is a pleasant room, and is finished in mahogany and white and gold panelling, and is distinguished by wide side windows which give an uninterrupted view of the scenery from all the tables. Seating accommodation for about 120 passengers is provided. Another pleasing feature is the fitting of Thermotank "punkah-louvre" ventilation to the first-class saloons. On the lower deck aft in the space used in other ships as the dining saloon a comfortable tea room and lounge and a smoke room have been arranged. The lavatory accommodation is good, and our impression of the ship's fittings generally was that they accord with the best liner practice. In the steerage accommodation and crew's quarters forward, the alterations are not so radical, but there is ample space on the promenade and main decks, while on the lower deck a large second-class dining saloon is provided. The galleys and kitchens are on the main deck forward of the boiler-room hatch, and good quarters are provided for the officers and crew at suitable parts of the ship. The usual complement of ship's lifeboats is carried on the shade deck and the after promenade deck, and further aft on the main deck is the steam steering gear, supplied by Bow, McLachlan and Co., Ltd., of Paisley, with the steam capstan engine built by Thomas Reid and Sons, of Paisley. Our general examination of the ship convinced us that excellent use had been made of all available space and that she is admirably designed for the service which she is to undertake.





ARRANGEMENT OF ENGINE AND BOILER ROOMS

THE PROPELLING MACHINERY.

As shown by the above elevation and plan, the main propelling machinery is arranged with the boiler-room amidships and the engines immediately aft of this space. Both rooms are entered from the main deck, a working passage being left on either side of the ship. The upper part of the engine-room, including the control platform, is only partitioned off by light glass screens so that some view of the machinery is given. As the boilers work under forced draught entrance to the stokehold flat is gained through an air lock arranged in the side of the boiler casing.

From the drawing it will be seen that there are four turbines driving the port shaft, namely, the high pressure unit right aft, the first and second low-pressure turbines immediately aft of the gear case, and the low-pressure turbine forward. On the starboard shaft the grouping is the same, with the exception that there is no high-pressure turbine. In order to give an equal division of power more steam is passed from the high-pressure turbine to the starboard intermediate-pressure turbines than goes to the port intermediate-pressure turbines. The arrangement of auxiliary pumps does not call for particular comment, but it may be remarked that twin condensers are fitted in each wing space, the two subdivided exhaust branches being controlled by hand-operated flap valves, so that in the case of undue salinity in the condensate, caused perhaps by a leaky tube, any condenser can be isolated and examined without having recourse to stopping the machinery.

As not unusual when new machinery is introduced, rumours as to the failure of the King George V. have been rife. We are able, however, to state on good authority that no difficulty has been experienced with these turbines other than the necessity of making slight alterations to the turbine gland sealing arrangements. Naturally, the turbine builders wished to proceed without undue haste, and the contractors' speed trials were delayed until the end of August, when they were successfully carried out on the measured mile at Skelmorlie. The machinery is designed for a total normal output of 3500 shaft

horse-power at a propeller speed of 570 revolutions per minute, corresponding to a ship's speed of over 20 knots. On the trials referred to the turbines developed 3730 shaft horse-power at 582 revolutions per minute with an H.P. turbine steam pressure of 465 lb. per square inch, while the boilers proved a success in every way. The speed of the ship was 20·78 knots. On the demonstration trial the machinery was not run at quite its full power, but throughout the day it worked excellently. Although there was a little smoke at times, as soon as the boilers settled down to regular load conditions it largely disappeared. The heat in the boiler-room was not excessive, owing to the careful ventilation arrangements, but the somewhat more confined spaces of the engine-room were perhaps hotter than we had expected. The difficulty of placing so much machinery which is working at a very high temperature in the shallow depths of from 9ft. to 10ft. is fully appreciated by the builders, and there should be no difficulty in securing an equitable engine-room temperature. Interest was added to the trial by the personal presence of Sir Charles Parsons, Mr. R. J. Walker, Sir Archibald Denny, Mr. Maurice E. Denny, Mr. Harold E. Yarrow, Mr. W. W. Marriner, Captain Alexander Williamson, and Mr. A. M. Macfarlane, all of whom have been prominently associated with this new venture. In our second article we shall deal mainly with the turbine and boiler plant and with the engine-room auxiliaries.

Models and Analogies for Demonstrating Electrical Principles.

No. V.*

In a lecture on "Vibrations, Waves and Resonance," delivered before the Royal Society of Arts in 1916, Dr. J. Erskine-Murray explained that the flow of electric current in a submarine cable has many points in common with that of water in a submerged pipe. The dielectric, for instance, is a hollow cylinder filled with and surrounded by a conductor, just as the pipe is surrounded by and filled with a fluid, while its thickness and its electrical rigidity, together with the resistance of the conductor in its core, control the amount of current under any given difference of pressure between its ends, in the same way that the flow of water in the pipe is controlled by the rigidity of the walls and the viscosity of the liquid. To demonstrate this, Dr. Erskine-Murray exhibited the model shown in Fig. 40. On a horizontal board a

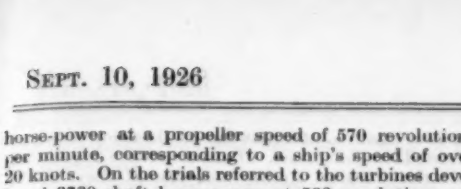


FIG. 40—ELECTRIC CABLE MODEL

rubber tube, 4ft. or 5ft. long, is placed, and it is filled with a mixture of syrup and water. At the left hand of the tube there is a syringe which is also filled with the same liquid. If the piston of the syringe be pressed a bulge is raised in the tube, and the swelling creeps along the tube, but no liquid leaves the tube until the bulge reaches the far end. This, Dr. Erskine-Murray explained, not only gives a true picture of the flow of electricity in a submarine cable, but also of the flow of water in any level pipe.

The dimensions and materials were chosen so that the time factor was magnified, and whilst the bulge took several seconds to travel along the tube, in the case of an electric cable the motion would, of course, take place with very much greater rapidity; indeed, the actual tube used represented a cable several thousand miles long. The moving bulge is a true wave or impulse, and not merely a mass of material moving forward, for the liquid put into the tube by the syringe remains at the same end, the movement of any particular drop of liquid being merely a small distance forward and outwards as the pressure rises behind it. The pressure travels the whole length of the tube, but the liquid only takes one short step. To make the phenomenon clear, small flags were mounted on wires, and were arranged so that as the bulge reached each flag it was made to raise and fall shortly afterwards. The elasticity of the rubber walls of the tube represents the capacity between the core of the cable and the sea water outside it, and the resistance due to the viscosity of the liquid, the electrical resistance of the core. In neither case is the inertia important, as the motion of the liquid is so slow that it is almost completely dependent on the resistance of the liquid and the elasticity of the tube, while in the cable the only factors of serious importance are the capacity and resistance. The greater the capacity, i.e., the thinner the walls of the tube, the slower does the impulse travel, and the increase of resistance, whether fluid or electrical resistance, produces a similar effect. The frequency of the waves used in cable telegraphy is about ten per second, and as the time that an impulse takes to travel from Ireland to Newfoundland is a large fraction of a second, there are several waves on their way along an Atlantic cable at one time.

In order to show the attenuation of waves and the distortion or loss of character of a complex wave as it progresses, the arrangement shown in Fig. 41 was exhibited.

This model consists of a piece of light fabric called butter muslin, with wooden stretchers across its

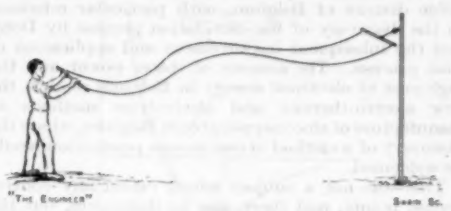


FIG. 41—EXPERIMENT SHOWING THE ATTENUATION OF WAVES

end, one of which is attached to the wall. To demonstrate the effect, the free end of the stretcher is drawn towards the lecturer until the fabric is pulled up almost in a horizontal plane. The end of the muslin is then moved slowly and steadily up and down, when large waves are seen to travel along it towards the wall. The up and down motion is then made much more rapid, when the short waves produced die out long before they have traversed the length of the muslin; indeed, they are quite imperceptible beyond a distance of a yard or two, thus showing that the attenuation of the short waves is greater than that of the long waves. Here, Dr. Erskine-Murray explained, is the reason why long waves are better than short waves for long-distance telegraphy of all kinds, but as far as wireless communication is concerned, this only holds down to waves of about 100 m., and for shorter waves the attenuation is less.

If both types of wave are set out at once by moving the hands up and down with a rapid vibration superposed on a slower one, in what may be called a series of jerks, the compound wave which goes along the muslin soon loses the ripples which give it its peculiar character, and long before it reaches the end becomes quite smooth. This affords an explanation of the difficulties of submarine telephony, and indeed of all long-distance transmission of complex waves.

The attenuation of short waves along a wire or of pulses along a cord may be reduced by adding inductance or inertia uniformly distributed along it. Each wave then represents a greater quantity of energy, and as the transverse motion is more rapid in a short wave than in a long one of the same amplitude, the energy is proportionately greater in the short wave. Hence the short wave is fortified against the attenuating influence of resistance and capacity, and the complex wave travels on with less distortion. For this reason it is easier to obtain harmonics on the wire-covered strings of a violin or guitar than on the lighter gut strings, and better articulation on a telephone cable loaded with inductance than on one with a single straight conductor.

Adding inductance naturally reduces the velocity of the wave along the conductor, but as the energy is not seriously decreased, this is of much less consequence than the improvement in the clearness of speech. In order to show resonance between two vibrators of the same kind, Dr. Erskine-Murray exhibited the model shown in Fig. 42. There are two torsional

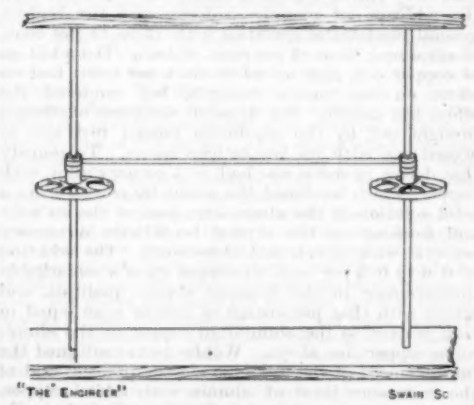


FIG. 42—APPARATUS FOR SHOWING RESONANCE BETWEEN TWO VIBRATORS

vibrators, consisting of small iron trolley wheels mounted axially on straight strips of steel springs, and the masses and thickness of the springs are such that the rates of vibration are equal. The wheels are coupled together by a thin endless band of rubber wound round the central bosses of the wheels, and one of which is set oscillating. Gradually the second oscillator commences to oscillate with steadily increasing amplitude, and after ten or twelve swings its motion is as great as that of the first oscillator.

The transference of energy does not stop here, however, but goes on until the original vibrator is at rest and the other is operating vigorously. Then it begins to come back and the whole process is reversed, this alternate transference from primary to secondary, and *vice versâ*, going on repeatedly until all the energy has been dissipated as heat through friction. The energy and motional conditions in this pair of vibrators are almost the same as in a pair of coupled electrical oscillating circuits tuned to the same frequency. The same swaying to and fro of the energy between primary and secondary takes place, and the phases and frequencies alter as in the mechanical vibrators. If instead of allowing both vibrators or circuits to oscillate freely, the energy be taken continuously from one of them, by pressing a paint brush against the rim of the second wheel, for instance, or by attaching an aerial wire to the secondary electric circuit, the conditions are altered. The secondary oscillation never attains a large amplitude, and may die out very nearly at the same time as the primary oscillation, this difference being due to the continual abstraction of energy from the secondary, which becomes almost solely a carrier of energy from the primary to the dissipator, and has little opportunity of storing it as oscillating motion.

This curious swaying of the energy from the primary to the secondary and back again is of the greatest importance in wireless work, in which so many coupled oscillating circuits are used. Obviously, it is unsatisfactory to find that the energy intended to be transferred to the secondary has almost all come back to the primary, and that neither the primary nor the secondary is oscillating at its natural rate of free vibration, but either faster or slower. Various schemes have therefore been devised to prevent the return. It is clear that if the coupling be loose—that is to say, if the transfer of energy be slow—it will be a long time before the reverse action commences and the purpose for which the energy is being put into the secondary may be practically accomplished before the reversal takes place—a case which, often occurs when the energy is being rapidly given out, as in radiation from a vertical antenna.

There is, however, another method by which the complications due to the return of energy to the primary may be avoided, namely, by destroying the coupling, or, what is much more simple in the electrical case, by introducing so much resistance into the primary at a moment when its motion ceases, that it is unable to move again under the impulses given to it by the secondary. Thus, it can absorb no energy, since the point of application of the force must move with the force if work is to be done. This can be shown very simply with the aid of the coupled torsional vibrators, shown in Fig. 42. If one of them be started, and, as soon as the other has got up to its maximum swing, the other be caught hold of as it stops and be held firmly, the second vibrator then goes on vibrating freely at its natural frequency, and does whatever work it is intended to do without returning any energy to the primary. In wireless work, this method is known as shock excitation, the current in the primary being finally stopped or quenched at any moment when all, or almost all, its energy has got into the secondary.

Dr. Erskine-Murray gave many instances of the generation of waves by the vibration of a free oscillator, and also dealt with the converse problem, namely, the conversion of the energy of a stream of waves into the vibration of an oscillator on which they impinge. In this case the principle of resonance becomes of immense value, for if it were not possible to absorb and store a small increment of energy from each wave as it comes along, and to add the increments up until the resultant vibration of the receiver becomes of appreciable magnitude, wireless telegraphy and telephony would be extremely limited in range and utility. An interesting experiment is illustrated in Fig. 43, where a cord is shown stretched

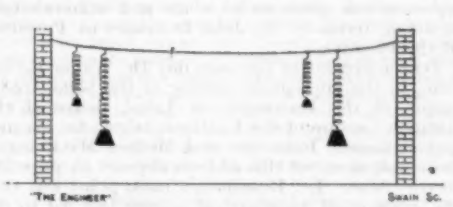


FIG. 43—MECHANICAL RESONANCE EXPERIMENT

across a room. Hanging from the cord near each end is a pair of vibrators, consisting of spiral springs attached to weights, one weight of each pair of vibrators being smaller than the other weight, and the spring stiffer, with the result that one weight bobs up and down more rapidly than the other. If one of the vibrators be set in motion—the slow-moving one, for instance—the corresponding vibrator commences to move up and down, and after a few swings it is going strongly, whilst the other vibrator keeps quite still. If, when this vibration ceases, the quick-moving vibrator be started, the corresponding vibrator at the opposite end of the string commences to work. Each vibrator responds to the tuned impulses sent along the cord, and if both vibrators at one end of the string be set into operation, both vibrators at the opposite end respond. If, however, the rates of

* No. IV. appeared September 3rd.

vibration of either pair of vibrators are altered by adding or subtracting weights there is beyond a few feeble, and erratic waggles no response at all.

The principle may be demonstrated in a slightly different and even more interesting manner by means of the arrangement shown in Fig. 44. Over each end

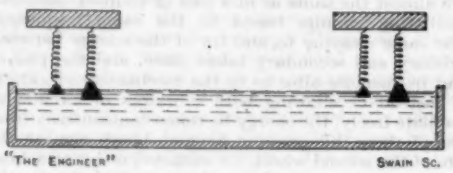


FIG. 44—MODEL FOR DEMONSTRATING RESONANCE

of a long water trough two pairs of vibrators are suspended from firm supports, each pair consisting of a slow and rapid vibrator as before. The weights are partially submerged in the water, and if one of the weights be moved up and down, it sends out waves which can be seen travelling along the trough. In a few moments the corresponding vibrator at the other end of the trough begins to move, and, as before, each vibrator is actuated by the corresponding vibrator of its own particular frequency at the opposite end of the trough. If both vibrators are started at one end, both respond at the opposite end, and if the frequency of either is altered, there is no response. Here, then, we have a vibrator producing a series of waves, and if there is a vibrator with a natural frequency corresponding to the incoming waves, there is an absorption of energy by resonance. The experiment also provides a proof that if the vibrator is not tuned to these waves, the energy is not absorbed. There is also proof that two sets of waves can co-exist in the same medium without mutual destruction, for when both vibrators at one end are started, both vibrators at the opposite end respond to them. In a like manner, it can be seen how two or more pairs of wireless stations can be worked independently and without interference in the same district, and how, in Squire's "wired wireless" system, a message transmitted by means of high-frequency current can be sent along a wire on which a telephone conversation is going on without either set of waves interfering in the slightest degree with the other.

The Institute of Metals.

No. I.

AUTUMN MEETING AT LIEGE.

ON the invitation of the Association des Ingenieurs Sortis de l'Ecole de Liége, the Institute of Metals held its autumn meeting in that city on September 1st, 2nd and 3rd, under the presidency of Sir John Dewrance. This is the second meeting which the Institute has held in Belgium, the first official visit being the meeting at Ghent in 1913, when an international exhibition took place in that city. The late Professor A. K. Huntington was president in that year. It was a comparatively small meeting, and great progress has been made by the Institute since that time. The membership of the Institute has increased in the thirteen years which have elapsed from 600 to 1750; the roll has assumed a more international character, and stands in a far wider sense than during the former visit to Belgium for the non-ferrous metals industries.

Last week's meeting was happily begun by a reception in the afternoon of September 1st by the civic authorities at the City Hall, when a formal but cordial welcome was given to members and acknowledged in fitting terms by Sir John Dewrance as President of the Institute.

On the evening of the same day Dr. Walter Rosenhain, in the appropriate setting of the Salle Académique of the University of Liége, delivered the Autumn Lecture of the Institute, taking for his subject "Ancient Industries and Modern Metallurgy." An abridgement of this address appears on page 287 of this issue. Dr. Rosenhain's main point was that the advance of metallurgical science had led to the production of metals of a high degree of purity which could not otherwise have been obtained. It was necessary, he showed, that this should be the case as the requirements of the engineer became more and more exacting. The progress demanded could only, it was insisted, be achieved if all concerned with metals, whether as users of the finished product or manufacturers of the metal or producers of the metal from the ore, or as scientific investigators, worked harmoniously together.

When members met in the Hall of the Association of Engineers on the morning of September 2nd, under the chairmanship of Sir John Dewrance, the first business was to present the list of honorary officers and members of Council.

The Secretary announced that Sir John Dewrance had been nominated as President; Dr. W. Rosenhain, Sir William Smith and Mr. Thomas Bolton as Vice-Presidents; and as members of Council, Mr. R. Lloyd Gibbins, Dr. H. Moore, Sir Charles Parsons, Mr. A. J. Smout, Professor F. C. Thompson, and Captain Hugh Vivian. There were no new nominations.

The meeting then proceeded with the reading and discussion of papers.

ZINC INDUSTRY OF LIEGE.

The first paper taken was one by Monsieur L. Bocheron on "The Zinc Industry of the Liége District." In this paper an historical account is given of the development of the zinc industry of the Liége district of Belgium, with particular reference to the discovery of the distillation process by Dony and the subsequent improvement and application of that process. The absence of water power and the high cost of electrical energy in Belgium renders the new electro-thermic and electrolytic methods of manufacture of zinc inapplicable in Belgium, where the discovery of a method of continuous production would be welcomed.

This was not a subject which raised any controversial points, and there was no discussion, but the author was warmly thanked for his contribution.

ALUMINIUM-SILICON ALLOYS.

Three papers dealing with the aluminium-silicon alloys were then presented for purposes of joint discussion. They were entitled "The Constitution and Structure of the Commercial Aluminium Alloys," by Dr. A. G. Gwyer and Mr. H. W. L. Phillips, with an appendix upon the "Properties of the Modified Aluminium-Silicon Alloys," by Dr. D. Stockdale and Mr. I. Wilkinson; "Some Mechanical Properties of Silicon-Aluminium Alloys," by Mr. J. D. Grogan; and "Silumin and its Structure," by Mr. Buntaro Otani.

The first of these papers deals with the constitution, structure and mechanical properties of modified aluminium-silicon alloys, and a theory based upon colloidal lines is put forward to explain the nature of the modified structures. Examples are given of the application of this theory to other alloy systems. The alloys possess good founding qualities, are appreciably lighter than pure aluminium, and in both chill and sand-cast states possess a high resistance to shock, excellent ductility and a high degree of incorrodibility. In his paper, Mr. Grogan describes the sodium and "salts" methods of modifying silicon-aluminium alloys. The "salts" method is preferred. Some mechanical properties of 1in. diameter chill and sand-cast bars are given. Ternary alloys containing also magnesium or zinc are not superior to the binary alloys. In his notes on silumin, Mr. Otani remarks that the chief development of aluminium-silicon alloys during the last three years has been in the direction of a marked increase in mechanical properties, owing to the modifying action caused by the addition of metallic sodium or alkali fluoride to the molten alloy. He puts forward a theory which he believes will satisfactorily explain the process of modification.

In the discussion on this group of papers, Miss M. Gayler said that she had obtained results very similar to those given by Dr. Gwyer. Of the two theories put forward, it seemed to her that the colloidal theory carried the greater weight. There were many points of interest in the contributions. She was not in agreement, however, with the work of Mr. Otani.

Dr. G. Welter gave an account of some investigations in which he had been engaged on the aluminium-silicon alloys with the object of raising the endurance limits of the material. The highest tensile strength and elongation were reached by the modification of silumin with from 0·1 to 0·5 per cent. of metallic sodium or 2 to 3 per cent. of sodium chloride or sodium fluoride. The best general values were attained with the addition of metallic sodium, and the highest general mechanical qualities with 12 to 14 per cent. of silica and ·6 to ·9 per cent. of iron. The addition of copper and zinc up to about 1 per cent. had no effect on the tensile strength, but rendered the alloys less ductile. The dynamic weakness of silumin brought out by the pendulum impact test was in accordance with its low fatigue range. To remedy that defect recourse was had to a ternary alloy with copper, which hardened the metal by constituting a solid solution of the aluminium part of the eutectic and forming on the crystal boundaries a ternary eutectic with silicon and aluminium. The addition of 0·6 to 0·8 per cent. of copper gave a remarkable improvement in the dynamic elastic qualities, and alloys with that percentage of copper were equal in that respect to the aluminium copper or the aluminium-copper-zinc alloys. Wöhler tests confirmed the improvement of the dynamic elastic qualities and of the endurance limit of silumin with added copper. It was seen to be proved therefore that the only disadvantage which silumin possessed could be rectified by the addition to the aluminium-silicon alloy of 0·6 to 0·8 per cent. of copper. That ternary alloy also possessed better properties from the workshop standpoint. The changes brought about in the properties of the material by the addition of less than 1 per cent. of copper were indeed most remarkable.

Mr. S. H. Edwards said that several of those who had been engaged in the work had shown that modified structures could not be obtained by chill castings alone. The paper by Mr. Stockdale and Mr. Wilkinson indicated a preference for the 11 per cent. alloy. It was claimed that it had higher shock-resisting qualities, better elongation, and that the modification obtained persisted for a long time. If members were acquainted with the work of Archer and Kempf they would be aware that with the alloy dealt with an improvement in the tensile properties over a period of from ten to fifteen months was obtained when ·1 per cent. of sodium was used as the modifier. The time question had to be considered in these matters, and if it were necessary to wait for maximum results that would be a heavy financial burden under ordinary operating conditions. His own experience suggested that the waiting period could be reduced if the quantity of modifier used were reduced to ·045 or ·06 per cent. The choice of caustic soda as the modifier by Mr. Stockdale and his co-worker was interesting, but he would like to hear the reasons which led them to employ it. He agreed as to the injurious effects of certain elements when added to the silicon alloys, and would point out that as small an addition as ·5 per cent. of copper reduced the elongation of the 13 per cent. silicon alloy to 3 per cent. Tin and lead had even more serious effects on the elongation qualities, but had no influence otherwise Antimony, however, reduced both the strength and elongation properties of the material. Manganese was helpful up to about ·5 per cent. Mr. Grogan's paper dealt with the aluminium-silicon alloys from the aspect of the effect of modification on the mechanical properties of the material. He would remind the meeting in that connection that there were good economic reasons for the use of sodium which cost only ·043d. per lb. of metal modified, compared with ·194d. when salts were employed, which was the method prefered by Miss Bingham, who was contributing a paper on an allied subject. It was a further advantage that a lower refining temperature could be employed whereby sodium was saved and melting charges were therefore reduced, and there was less risk of gas entering the metal. With regard to physical properties 4 tons tensile for the chill cast alloy at 350 deg. was the figure found. The sodium-treated alloy could also be rolled, and while not comparing favourably perhaps with heat-treated duralumin, was much stronger than pure aluminium, and resisted sea water corrosion equally well.

Dr. W. Rosenhain sounded a warning note. He said there were certain points concerning the aluminium alloys on which it was necessary to insist. It was true that for many purposes the aluminium-silicon alloy was very easy to cast, and could be given a surface appearance which made a great appeal to buyers and users, but from the point of view of strength qualities it was inferior to other alloys. No doubt if he could be persuaded to undertake the task, the foundryman could make a casting of almost any alloy. The main point he desired to make was, however, that it was necessary to sacrifice a little refinement in design and appearance in order to make use of greater unit strength, particularly at high temperatures. A figure of 4 tons at 350 deg. had been mentioned, but that was not in any way a remarkable figure and better results could be obtained. These criticisms apart, it was an advantage that as a consequence of the work done there had been brought about a widening of the basis of discussion of the whole problem of modification.

Mr. A. H. Mundey, speaking from the standpoint of the manufacturer, said that while it might be true to say that any casting which could be put on paper could be made, it was necessary to plead for that degree of co-operation between metallurgist and designer which would comply with the conditions experienced in practice. He welcomed the group of papers under discussion, as they brought before the manufacturer a great deal of information which he needed. He was particularly interested in the means adopted for the modification of the antimony-lead alloy. He was amazed at any attempt to modify that alloy with aluminium, which was a deadly enemy of zinc. A great deal more work must be done on the antimony alloys before manufacturers could offer them on the market.

Brief replies to the discussion were made on behalf of the authors, who will deal with the points raised more fully by correspondence.

SINGLE CRYSTALS OF ALUMINIUM.

Dr. D. Hanson presented a paper of which he, Mr. H. J. Gough and Mr. S. J. Wright are joint authors, on "Some Further Experiments on the Behaviour of Single Crystals of Aluminium under Reversed Torsional Stresses."

The paper describes an experimental study of the phenomena exhibited by single crystals of aluminium when subjected to alternating torsional stressing. The resulting distortion under this complex type of straining action is observed using slip-band measurements, and is related to the atomic orientation of the crystals by means of X-ray analysis. The observed complicated system of slip bands is then shown to be in agreement with the simple law that slip is confined, at any point of the surface of the crystal, to one of the octahedral planes and in the direction of the most highly stressed (shear stress) principal lines of atoms. The progressive hardening during a long endurance test has been studied and the phenomena attending the last stages of the test have been isolated from those of the earlier stages. Some quantitative data regarding hardening by slip have been deduced from

ball indentation tests made on cross sections of the specimens used.

This terminated the programme for the session.

Visits of inspection were paid in the afternoon to the works of Messrs. Cockerill at Seraing and the Société Anonyme Nouvelle Montagne. The last-named works are engaged in the zinc industry, and the methods adopted here are representative of practice to-day in this characteristic Liége branch of the metal industry.

The Association des Ingénieurs Sortis de l'Ecole de Liége gave a reception in the evening, at which a fine musical programme was carried through by members of the Liége School of Music. This was much enjoyed.

M. A. Stouls, speaking in French on behalf of the Association, gave a formal welcome to members, and supplied some interesting details concerning the magnitude of the zinc industry which had been founded at Liége. Dealing with the position occupied by Belgium in connection with the raw materials of the metals industries, he referred to the immense resources of the Belgian Congo in copper, silver, nickel, cobalt, bismuth, zinc, platinum, uranium, and other metals. The company operating in Upper Katanga had, he said, known reserves of 5,000,000 tons, and had produced over 90,000 tons of copper in the year 1925. Hydro-electric plant was being installed in Katanga to provide power for the mining and smelting operations. The possession by Belgium of the resources of the Congo gave her a high place in the production of the materials essential for the development of some branches of the non-ferrous metals industries.

Sir John Dewrance, speaking also in French, acknowledged the welcome accorded to members of the Institute, and expressed the hope that an early opportunity would be presented of receiving Belgian metallurgists in England.

Comparison of Static and Dynamic Tensile and Notched-Bar Tests.[1]

By KOTARO HONDA, Sc.D.,[2] Member (Sendai, Japan).

Introduction.

Machines for testing materials have recently considerably increased in number; for instance, referring to the methods of testing, there are the following tests:—Tension, bending, torsion, toughness, fatigue, abrasion, hardness, and single and repeated impact tests, &c. Since for each of these tests we have several types of machines, the number of types of testing machines as a whole is very large, and, further, new machines are continually being invented. Consequently, it is of importance to study the merits and demerits of these machines and to make a selection of those which are best for the purpose. In the Research Institute for Iron, Steel, and other Metals, Sendai, Japan, an investigation in this direction has already been commenced; in the present communication some general considerations regarding the relation between impact and static tension tests, and impact and static bending tests, and also regarding the method of measuring fatigue, will be given.

Energy for the Breaking of a Test Piece.

In the first place, the energy required for the simple breaking of a test piece will be considered. The force which resists the break is the atomic force, whose magnitude determines the so-called breaking strength by which the test piece is broken. When the atoms constituting the test piece are in their natural position of equilibrium the attraction and repulsion between them are in equilibrium and their resultant is zero. If an external force is applied to displace the atoms from their original position, the attraction or repulsion comes into play to oppose the displacement. In general, the force acting between every two atoms is expressed by an equation having the following form:

$$F = \frac{a}{r^{m+n}} - \frac{b}{r^m}$$

where r is the distance between two adjacent atoms, a b are two positive constants, and m n two positive integers, depending on the properties of the substance. The first term of this expression denotes the repulsive and the second the attractive force. If the test piece is made of a NaCl or KCl crystal, consisting of an assemblage of two different kinds of atoms charged with positive and negative electricity e, the values $b = e^2$, $m = 2$, and $n = 7$, explain quantitatively many properties actually observed. The (F, r) curve has a form as shown in Fig. 1.

The resisting force which comes into play, when the test piece is to be broken, is the sum of the above-mentioned atomic forces; hence it is also given by an expression having the same form as that of F. Hence the resisting force acting normally on the transverse section of the test piece is zero before the tension is applied, becomes greater with the elongation caused by the tension, attains a maximum when the distance between two adjacent atoms becomes equal to r_m in the figure, and then decreases rapidly with the further increase of the distance. Consequently if the application of the maximum tension is continued without decreasing its magnitude, one half-portion of the test piece obtains an acceleration and breaks into two pieces.

In the case where the test piece is broken very slowly, so that the external and resisting forces are always in equilibrium, the work required for the break can be calculated. Thus we have:

$$W = \int_0^\infty F \, dr,$$

and when F is known as a function of r, W can be calculated. The investigation in this direction has been developed by M. Born and O. Stern,[3] G. Wulff,[4] and by M. Yamada.[5] In the case of NaCl the calculation of the work

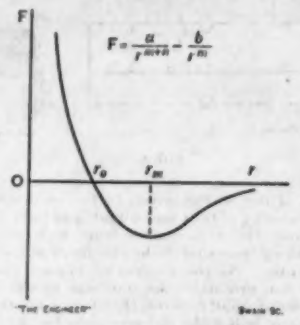


FIG. 1

has already been made. For instance, the work required for breaking the test piece in the direction perpendicular to the face (001) is:

$$W_{(001)} = 0{\cdot}116 \frac{e^2}{a^2} = 147 \text{ erg/cm.}^2$$

where e denotes the electron charge and a the constant of the space-lattice. Further, the work of breaking in the direction perpendicular to the face (110) is:

$$W_{(110)} = 0{\cdot}310 \frac{e^2}{a^2} = 398 \text{ erg/cm.}^2$$

If the test piece consists of an aggregate of a large number of small crystals, the value of W comes out near the mean of the values for the faces (001), (110), (111), &c. If the surface of the fracture is not a plane, but rough, it is clear that the value of W becomes much larger. But on the whole the work done during a slow breaking is very small, and can be neglected in comparison with the amount of work required in the actual process of breaking, which is about 10^3 erg/cm.^{2} In the case of iron a similar calculation has not yet been possible, but, judging from the actual work required for breaking iron and NaCl, we may conclude that in the case of iron also the work required for the simple breaking is very small as compared with that actually needed.

If we consider the case of a test piece broken very slowly, the energy required for breaking it appears as the two surface energies distributed on the two faces of fracture. Taking A and B in the annexed figure as the surface

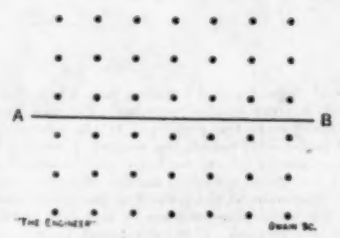


FIG. 2

of fracture, let us consider attraction between the atoms arranged on both sides of it. The principal force coming into play is the attraction between the atoms which are situated nearest the plane A B on both sides. The atoms which are situated outside those inner ones have also some attraction, but it diminishes rapidly with the increase of the distance from the plane A B, so that after breaking the test piece the atoms near new surfaces are displaced to some extent outwards perpendicularly to the surface of separation. This displacement occurs only in atoms very near the surface, and in a part a little beneath the surface the atomic distance has a constant value which is characteristic of the surface. Only atoms which are near the surface have their potential energy increased. This energy, or the surface energy, must be equal to that required for breaking the test piece.

Let us next consider the case where the test piece is broken suddenly. If we try to break the piece by applying a large force, the breaking begins to take place under the external and the resisting forces which are nearly in equilibrium, until the distance between the atoms increases to r_m, but above this limit the external force is always greater, so that the breaking of the test piece proceeds with an acceleration, and hence requires more energy than in the above-mentioned case, where it takes place infinitely slowly. This excess of energy, after breaking the test piece, transforms itself finally into heat.

Next we shall consider the actual case of breaking a test piece by making use of the tensile strength or bending test machine. The energy in this case may be divided into three parts:

(1) The energy required for simple breaking of the test piece, $W_1 = P_1$.
(2) The energy required for deformation, $W_2 = P_2 + H_2$.
(3) The kinetic energy, $W_3 = H_3$.

The first part, W_1, is the potential energy, P_1, of the surface of separation, and is, as has already been mentioned, very small. The second part, W_2, is the principal term, and consists of the work of deformation, of which a small fraction remains in the specimen as the potential energy of the interstrain P_2 and the remaining part, after the break, escapes as the heat energy H_2. The third part, W_3, is the kinetic energy. This again is emitted finally as heat energy H_3. W_3 is also a small quantity. Hence for the total energy W we have:

$$W = W_1 + W_2 + W_3 = P_1 + P_2 + (H_2 + H_3),$$
$$W - (H_2 + H_3) = P_1 + P_2 > 0,$$

hence

$$W > (H_2 + H_3).$$

Thus the quantity of heat generated at the time of breaking must be somewhat smaller than the whole work done. This has already been confirmed experimentally by H. Hort.[6] His result of experiment with a bar made of Krupp iron, 2 cm. in diameter and 9 cm. in mark distance, showed that the work required for the breaking was 5070 cm. kg., or 118·8 gr. cal., and the heat generated 106·8 gr. cal., the difference amounting to about 10 per cent. Recently, Farren and Taylor[7] have also arrived at a similar conclusion. Since P_1 is negligibly small compared with P_2, we may draw the conclusion that most of this difference of energy must be the energy of internal strain. In our Institute we are trying to make the actual measurement of the energy of this internal strain by means of a high-temperature calorimeter, and to confirm the correctness of the above conclusion.

That the energy which is required for the actual breaking of the test piece is much greater than that of the theoretical value is due to the fact that most of the work is chiefly used up in the deformation of the test piece. Consequently if F be the stress and S the strain,

$$W \fallingdotseq \int F \, S \cos\theta \, d\,V.$$

Also since

$$F = f(S),$$
$$\therefore \quad W \fallingdotseq \int S f(S) \cos\theta \, d\,V.$$

Consequently, if the mean value of $S f(S) \cos\theta$ be denoted by φ,

$$W \fallingdotseq \varphi \, V,$$

where V is the volume subject to stress. If φ be constant, W is proportional to V. This has already been tested by Moser[8] in the case of some carbon steels with test pieces of different widths, and the correctness of the result has been confirmed. In the case of the impact test it has been found that the work W required for the break is not in many cases proportional to the sectional area of the notched part, because the volume V which is subject to strain is not proportional to the sectional area. But in the case of Moser's experiment the ratio W/V remains constant

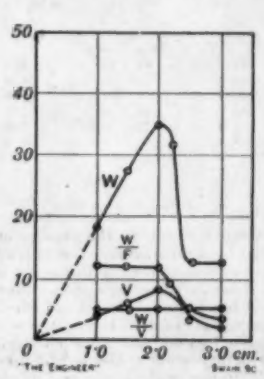


FIG. 3

as seen from Fig. 3. The material used was an annealed carbon steel and the velocity of impact was 7·84 m/sec.

Relation Between the Statical and Dynamical Tests.

If we assume that in these two tests the same deformation is caused before the break, W must be the same whether the test is static or dynamic, since the work is chiefly determined by the energy of deformation. As the energy depends only upon the state of the test piece both before and after the break, the amount of energy required for the break must be the same, if the corresponding states of the test pieces in these two tests are the same, and the kinetic energy of the test piece is assumed to be negligibly small.

In the case of tension tests it is, however, observed that the energy absorbed in the impact test is generally greater than that absorbed in the statical test.[9] This difference is also due to the difference in deformation in these two tests. Thus, if the general elongation be less in the impact test than in the statical test, the local elongation may be greater in the former test than in the latter. Hence, though the total elongations be the same in these two tests, the actual deformations in these cases may differ from each other, and the energy absorbed may be greater in the impact than in the statical test. Table I. on page 276 contains an example of the comparison between these two tests made in our Institute.

Here the diameter of the test piece is 10 mm. and its gauge length 100 mm. In the case of bending tests it is confirmed that the same amount of energy is required both in the dynamic and the static tests.[10] For instance, our result in static and dynamic tests with notched specimens, shown in Fig. 4, is as shown in Table II.

This equality means that with the same specimen the break occurs at the same bending angle, i.e., at the same amount of deformation. According to the investigation

[1] Institute of Metals—Liége meeting, September, 1926.

[2] Professor of Metallurgy, Tôhoku Imperial University; Director, Research Institute for Iron, Steel and other Metals, Sendai, Japan.

[3] *Sitz. K. Preuss. Akad. Wiss.*, 1919, 901.

[4] *Z. Krist.*, 1901, 34, 449. See also P. Ehrenfest, *Ann. Physik*, 1914 [iv.], 48, 360, in which a complete bibliography of the literature is given.

[5] *Sci. Rep. Tohoku Imp. Univ.*, 1924, 13, 27, 53.

[6] H. Hort, *Z. V. d. I.*, 1906, 11, 1831.

[7] Farren and Taylor, "Proc.," Roy. Soc., 1925 [A], 107, 422.

[8] Moser, *Stahl u. Eisen*, 1922, 42, 90; *ibid.*, 1923, 43, 936.

[9] F. Körber and R. Sachs, *Mitt. K. W. Inst. Eisenforschung*, 1922, 4, 14. Other literature is summarised in this paper.

[10] Cornu-Thénard, *Compt. Rend.*, 1919, 168, 1315.

of R. Yamada,[11] who carried out the impact tests on various steels at different low temperatures, the work required for the break by impact is proportional to the angle of bending, and, moreover, the straight line which expresses this relation nearly passes through the origin of the co-ordinate. This fact shows that the work which is required for breaking the test piece without any deformation is very small, and supports the conclusion reached in the foregoing section. Some results of his experiments with a steel of 0·3 per cent. carbon content, which was water

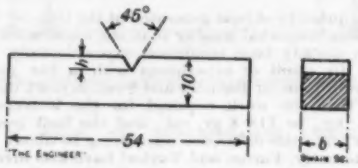


FIG. 4

quenched and tempered at 700 deg., 600 deg., and 530 deg., are given in Table III and in Fig. 5 :—

There are, on the other hand, some scientists who try to attribute the difference in energy absorbed in the static and the dynamic tests to that of the isothermal and adiabatic breaking, but this idea does not fit the facts. The idea would mean that this difference in these two tute. In this experiment the test was made with Charpy's machine, whose hammer weight was 22·46 kilos. The form of the specimen is shown in Fig. 6. The material was a carbon steel and all were annealed.

Repeated Impact Test.

In repeated impact tests the energy given to the test piece each time is very small, but the accumulation of it finally breaks the test piece. At the beginning of the

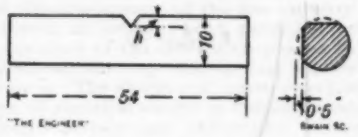


FIG. 6

impact part of the energy given to the specimen is dissipated as the energy of heat and sound, and part is returned to the hammer, the consequence being that only a small fraction of energy remains in the specimen as the potential energy of strain. As the process of impact goes on the energy of strain gradually accumulates in the test piece until a number of small fissures, thus formed in the interior of the specimen, will make the specimen break. Thus the fatigue of the specimen is almost zero at the initial part of

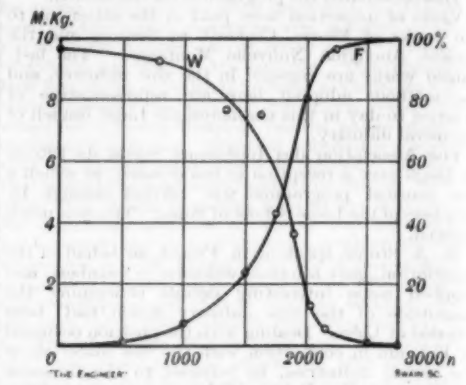


FIG. 8

measuring some other physical properties. For instance, if we find the relation between the number of repeated impacts and the electrical conductivity or magnetisation, and also study the relation between the latter and F, we

Table I.

Carbon. Per cent.	Elongation. Per cent.			Area contraction. Per cent.			Work of rupture. M.kg./cm².		
	Static.	Dynamic.	Dyn. Stat.	Static.	Dynamic.	Dyn. Stat.	Static.	Dynamic.	Dyn. Stat.
0·1	41·5	35·6	0·86	72·0	70·6	0·98	12·1	15·5	1·28
0·3	32·9	31·6	0·96	51·0	58·7	1·15	13·2	19·6	1·48
0·5	24·2	24·7	1·02	36·0	44·5	1·23	12·1	17·1	1·41
0·7	18·0	18·7	1·04	22·6	33·4	1·48	10·0	13·4	1·34
0·9	12·1	11·4	0·94	13·2	12·0	0·91	7·7	10·2	1·32

Table II.—*Energy of Rupture m.kg./cm.²* (*Mean Values of Two Independent Tests*).

h.	h.	0·3 per cent. C annealed at 900°.		0·3 per cent. C water quenched at 900°. Annealed at 600°.		h.	10–h.	0·3 per cent. C annealed at 900°.	
		Dynamic.	Static.	Dynamic.	Static.			Dynamic.	Static.
10	2	5·0	5·5	15·6	15·5	8	9·5	11·7	11·6
8	,,	4·5	5·0	12·9	13·8	,,	8·5	5·6	5·7
6	,,	4·9	5·5	19·5	13·7	,,	7·0	3·8	4·4
4	,,	5·5	6·2	14·3	14·0	—	—	—	—

Table III.

Temperature, ° C.	Tempered at 700° C.		Tempered at 600° C.		Tempered at 530° C.	
	Work of rupture, m.kg./cm.².	Angle of bending.	Work of rupture, m.kg./cm.².	Angle of bending.	Work of rupture, m.kg./cm.².	Angle of bending.
		Deg. min.		Deg. min.		Deg.
2	31·7	88 30	23·4	61 30	19·6	40
— 25	30·2	78 30	20·0	50 30	16·5	34
— 45	26·1	66 30	18·4	44 0	15·5	36
— 70	20·0	55 0	12·0	33 30	9·6	18
— 100	8·4	23 0	5·8	17 30	4·8	6
— 190	1·0	0	0·5	0	0·9	0

Table IV.

0·1 per cent. C, h = 1·5 mm.			0·5 per cent. C, h = 0·5 mm.			0·9 per cent. C, h = 0·5 mm.		
Impact velocity, m./sec.	Impressed energy, m.kg.	Absorbed energy, m.kg.	Impact velocity, m./sec.	Impressed energy, m.kg.	Absorbed energy, m.kg.	Impact velocity, m./sec.	Impressed energy, m.kg.	Absorbed energy, m.kg.
5·1	30·0	3·6	5·1	30·0	5·4	5·1	30·0	1·4
4·8	26·7	4·2	4·7	25·7	5·4	4·5	23·5	1·0
4·6	24·6	3·9	4·5	23·5	4·6	4·3	21·0	0·9
4·4	22·3	4·6	3·7	15·6	6·0	3·7	15·6	1·0
4·2	19·7	4·5	3·0	10·3	5·3	3·0	10·3	0·9
3·8	16·9	4·5	2·6	7·8	5·3	2·2	5·6	0·8
3·0	10·3	4·0	2·4	6·6	5·8	1·4	2·1	0·8
2·4	6·6	4·5	2·2	5·6	—	—	—	—
Mean		4·2	Mean		5·4	Mean		1·0

methods of breaking is due to the change of strain and stress as affected by temperature. But this effect is probably too small to account for the difference in the quantities of work done in these two tests. Moreover, even when the static breaking is carried out slowly, the temperature rise is considerable. Hence the static test can never be considered as an isothermal change. It follows, then, that the deformation is the most important factor affecting the difference in the static and dynamic energies absorbed.

Next we shall consider how much the absorbed energy in the case of the impact test is influenced by the variation in the velocity of the hammer before the impact. If the test specimen is assumed to be broken when it is bent at a

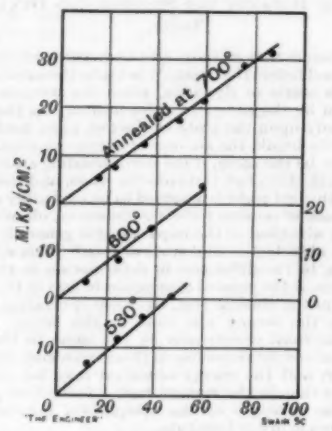


FIG. 5

certain definite angle, the absorbed energy will be independent of the hammer velocity. For the pressure exerted on the test piece, being the change of momentum of the hammer, must be nearly equal to the reaction of it, so long as the test piece remains unbroken, and hence depends only on its property and size. Consequently, the energy required up to the moment of fracture must be independent of the velocity. This conclusion has already been confirmed by previous investigators.[12] What is described below is taken from the experiments made in our Insti-

[11] R. Yamada, *Kinzoku no Kenkyû*, 1925, 2, 655.

[12] Charpy and Cornu-Thénard, *J.* Iron Steel Inst., 1917, 96, 61. Other literature is summarised in "Proc.," Amer. Soc. Test. Mat., 1922, 22, 9.

the repeated impacts, and appears first when the impact is repeated a considerable number of times, and then increases comparatively rapidly. If the energy of each impact is sufficiently small the energy given to the test specimen is partly given back to the hammer and the other is transformed into the energy of heat, none being left in the specimen as the potential energy of strain. In this case the break does not occur however many times the impact be repeated. This corresponds to the endurance limit.

To measure the degree of fatigue in repeated impact test the following method seems to be most convenient. A number of test pieces of the same dimensions were made of the same material and each treated thermally in the

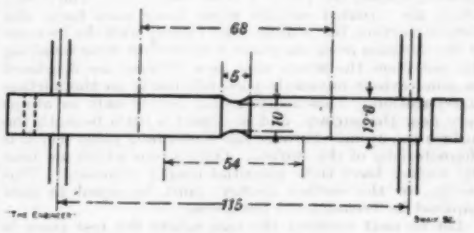


FIG. 7

same way. Before beginning the repeated impacts the absorbed energy W_0 is measured by a Charpy machine; then a certain number of repeated impacts are applied to another test piece; then it is taken out from the machine and the energy W required to break it by a single impact is measured, and so forth. Then the degree of fatigue is defined by the following expression :—

$$F = \frac{W_0 - W}{W_0}$$

If expressed in percentage, the 100 per cent. indicates that no energy is required for breaking and the fatigue is complete. The relation between F and the number of impacts n is given by a curve shown in Fig. 8. The material here used was an annealed 0·3 per cent. carbon content steel, and the dimensions of the test specimen are given in Fig. 7. In this impact test the hammer weighed 4·25 kilos. and the falling height was 3 cm. In the case of the single impact test, 68 mm. of the central portion of the test specimen were cut off, and the distance between the two supports of the Charpy machine was 54 mm. In practice it is not convenient to break the test piece during the course of the repeated impacts to determine the degree of fatigue, but this quantity can be found indirectly by can find from the measurement of electric conductivity or magnetisation with respect to the number of impacts the degree of fatigue due to the repeated impacts.

Books of Reference.

Wasserkraft-Jahrbuch. By Professor K. Dantscher and C. Reindl. Munich: Published by Richard Pflaum A.G., Munich. Price 24 marks.—Although it bears the date 1924 in the title, this volume was only completed last year. It is the first of a series of handbooks, which are to be published at intervals of about a year, and which will deal with the development of hydraulic power schemes in Europe. In the first chapter the subject is treated historically, and the rise of the use of water power is traced from earliest times up to the present large power turbine installations. Thereafter follows a series of chapters in which the progress made in the individual countries of Europe is recorded and illustrated. A second section of the book is devoted to a consideration of the economical and legal aspects of hydraulic power undertakings. Dr. L. A. Ott contributes an interesting chapter on discharge measurement, which is an extension of the discussion of the chapter on discharge measurement embodied in the British standard test code for hydraulic power plants, which was presented at the recent World Power Conference. This chapter of the handbook has been also printed as a separate brochure by the same publishers. Other sections of the volume deal with the conflicting interests of river navigation and water power schemes, water storage by pumping, the construction of reinforced concrete canals and flumes, various pipe systems, and relief works and overflow sluices. In the final chapters water turbine design and construction is discussed, there being chapters on such subjects as cavitation, the effect of the suction pipe, transmission gearing, fully automatic regulation and turbine governor improvements. The appendix contains some useful measurements and coefficients in British and metric units. It was intended to include a section giving a complete bibliography of all articles dealing with hydraulic power plant which had appeared in the year under review, but on account of the size of the present volume it was decided to omit this feature, and incorporate it in the new edition of the handbook which is now in preparation.

Considerable progress has been made in the plans for holding an exhibition of ironmongery, hardware and domestic appliances at the Royal Agricultural Hall, Islington, N., between November 15th and 20th.

Railway Matters.

OWING to a landslide, after heavy rains, the mail train from Barcelona to Valencia was derailed on September 1st. Twenty-five people were killed.

THE Manchester Corporation has adopted the old wooden staff system, used on single lines of railway, for controlling the movements of tramcars on single tracks in foggy weather.

THE difficult case of the railway shopmen has not, after all, been disposed of. After a lot of trouble, the National Union of Railwaymen got the other unions to accept a scheme. It was, however, rejected by a conference of N.U.R. delegates on August 31st.

THE coroner's inquest into the nine deaths that resulted from the level crossing disaster at Naworth on August 30th was opened on the following day and adjourned until next Tuesday, September 14th. The Ministry of Transport inquiry was held on Thursday, September 2nd, by Lieut.-Colonel Mount.

IT is officially announced that Mr. R. W. Gairns, now district engineer, L.M.S. Railway, Perth, has been appointed engineer for the central district, and stationed at Union-street, Glasgow; and that Mr. J. W. Melville is to be the South-Western district engineer at St. Enoch's Station, Glasgow. Mr. H. Riach succeeds Mr. Gairns at Perth.

IN pursuance of the powers conferred by the London Traffic Act, 1924, the London and Home Counties Traffic Advisory Committee has appointed Sir Henry P. Maybury, Sir Henry Jackson, Mr. J. R. Pakeman, Mr. E. B. Barnard, and Mr. J. Cliff to hold a public inquiry into the alleged inadequacy of travelling facilities to, from, and within the areas of the Metropolitan Boroughs of Bermondsey, Southwark, Camberwell, Deptford, Greenwich, Lewisham and Woolwich, and to report to the said Committee upon the facts of the case. The inquiry will be held at the Middlesex Guildhall, Westminster, commencing at eleven o'clock in the forenoon on Monday, October 11th, 1926.

THE Sowerby Bridge–Rishworth branch of the former Lancashire and Yorkshire Railway was built with the obvious intention of being extended to Shaw on the Oldham and Rochdale line, and thus afford an alternative route for the heavy valuable traffic on the main line between Lancashire and Yorkshire, and as a competitive route to the London and North-Western Huddersfield and Manchester line. It was opened to Ripponden in August, 1878, and to Rishworth in March, 1881. It is a double line throughout, but in view of the light traffic only one road is used for running purposes, and the other is kept as a siding, and mainly utilised for storing carriages. For the holiday traffic there were over 100 carriages standing there recently, but evidently the hand brakes were either not properly secured or they were maliciously released. Anyway, the carriages ran away down the falling gradient towards Sowerby Bridge, but at Watson's Crossing Station the siding was "trapped" on each side of the road level crossing, and so the leading vehicles were derailed.

THE facing point locking bar was invented in 1867 to prevent points being moved when any vehicle was on them. It was attached to the rail, and normally clear of the flange of the wheels. The movement of the points raised the bar, and if a vehicle was on the points the bar would impinge against the flenge of the wheel and the movement would be stopped. The bars were 15ft. or 18ft. long at first, and that was sufficient to meet the then wheel base, but as the latter was increased the length was added to to suit. When bogie coaches were introduced, the bars were made 27ft. long and now they are 33ft. long—on the Great Western some bars are 50ft. long. The latter unusual length may be avoided by the use of six-wheeled instead of four-wheeled bogies. It was the necessity to add to the length of its locking bars that has caused the London and North-Western Company to retain coaches with three axles—two end and one central—instead of following the example of its neighbours and adopting bogie stock. These points in railway signalling history are prompted by the rear portion of a passenger train having been derailed at Portsmouth Town Station on April 23rd last. The locking bar there was 33ft. long, but the presence of other points necessitated a special form, and for a certain, movement the equivalent of only 22ft. was given. As the coach in question had a wheel base of 25ft. 2in., it was possible to move the bar between the wheels. According to the recently issued report by Major Hall on the derailment that resulted, the length is to be protected.

DURING the general strike there was a collision, on Monday, May 10th, at Bishop's Stortford, in the southern area of the London and North-Eastern Railway. A passenger train left Cambridge at 1.42 p.m. for London, and arrived at Bishop's Stortford at 2.52. At 2.8, or 26 min. later, a train of perishables left Cambridge, also for London. The driver of this train said he was told that he was to run as a non-stop. The report by Lieut.-Colonel Mount said that the driver "was given no timing, being expected to run to the specified speed restrictions, of which he was aware, and to keep a sharp look-out. Neither did he know of the running of the passenger train ahead of him, and for some unexplained reason—possibly because this was a specially arranged train of foodstuffs—he thoughtlessly formed the impression, then and there, that he would have a clear road the whole way. In fact, he said he took it for granted that there was no train in front of him." The line was worked on the time-interval system, but as the goods train proceeded on its journey it gradually reduced the interval of 26 min. to one of 3 min. at the station before Bishop's Stortford, but no warning by red flag was given the driver of his nearness to the passenger train. The train was running at 10 to 12 miles per hour when entering Bishop's Stortford Station, but the driver did not see the standing passenger train, owing to a curve, an overbridge and some engines standing on adjoining lines. As a consequence of the collision which followed, some of the platform roofing was knocked down, and part fell on a passenger who had just alighted from the train, and he was killed. Colonel Mount concludes his report by observing that all concerned were doing their best in very trying circumstances, and that it would be unfair to criticise what happened.

Notes and Memoranda.

IT is noteworthy that, according to official statistics, over 55 per cent. of the motor cars registered in Shanghai are of American make.

THE rainfall record of New York is said to have been broken during the early days of August when 2·46in. fell in one hour, and of this amount 2·34in. fell in half an hour.

THE output of iron of the Han Yeh Ping Company, Central China, from May to October last year, was in metric tons:—May, 5453 tons; June, 9497; July 10,250; August, 11,465; September, 10,793; October, 6024; total, 53,482 tons.

ACCORDING to the *Anglo-Norwegian Trade Journal*, an Amsterdam firm has evolved a process which is claimed to allay the dustiness of roads by treatment with the residue left during the distillation of alcohol from sugar molasses. Successful experiments in the use of cellulose lye for spraying dusty roads have been made by the town engineer of Fredrikstad.

A MESSAGE from Cherbourg states that the new radio-electric mast which has been erected at the Casquets for the purpose of guiding ships at a distance worked for the first time this week. The new system enabled the President Harding to manœuvre without difficulty in a thick fog. The captain declared himself very satisfied, and expressed the hope that many similar stations would be installed on the English coast.

THE latest official estimation of the population of China is 448,231,000 people, of which 336,841 are foreign. The greatest foreign population is Japanese, with 218,351, as compared with British, 15,247; American, 9844; and German, 3050. Among the Treaty Ports Hankow, or rather the triple cities of Hankow, Hanang and Wuchang, head the list in population, with 1,583,000. The population of Shanghai is put at 1,500,000 and that of Tientsin at 800,000.

TESTS conducted at the Pittsburgh, Pa., experiment station of the American Bureau of Mines, have demonstrated that oil shale dusts are explosive, and that their explosiveness increases with their combustible content. The formation of dust during the mining and handling of oil shale is almost unavoidable, and the Bureau considers that the same precautions against dust explosions should be taken in the industries producing or working with oil shale as are taken in safely operated coal mines.

SPAIN, according to the Commercial Secretary to H.M. Embassy at Madrid, is the ideal country for motor transport, owing to its exceedingly mountainous character. Railways will always be costly to construct, and on many sections the agricultural traffic is insufficient to secure adequate returns on capital expenditure. For these reasons alone motor transport must develop, and it is not too late for the British manufacturer to obtain a share of the business if he will only realise that he must change his methods.

IN an informative article in the *Chemical Trade Journal*, on "The Chilian Iodine Industry," it is explained that at present not more than 2 per cent. of the iodine available in the nitrate industry is being extracted. This is perhaps the most unparalleled industrial waste in the history of the world. The life of the nitrate deposits is limited, and it is doubtful if the competition from synthetic nitrates can be met for more than fifty or sixty years longer. Where will the world's supply of iodine come from then, and what will the price be?

THE proved diamondiferous area of British Guiana extends in a northerly and southerly direction from the Potaro River to the Cuyuni River, a distance of 150 miles, and eastward for 40 miles from the foot of the Pakaraima Mountains. The Mazaruni fields, now the most important, are in about the centre of this area. The diamonds are accompanied by certain heavy minerals, such as tourmaline in the amorphous and crystalline forms, black sands consisting largely of ilmenite with some ferro-magnesian minerals, and gold in more or less quantity.

IN discussing the present stage of development of cellulose lacquers, the *Chemical Trade Journal* says that an elementary test for flow consists merely in pouring a small quantity of lacquer on a clean glass plate held at an angle of 45 deg. from the horizontal. A poorly flowing lacquer will run down the plate in narrow faltering ribbons, whereas a lacquer having proper flow qualities will descend in a band as broad as the original pouring and with regularity. Different lacquers cannot be directly compared by such a test unless the viscosity of each is approximately the same. Good flowing and bad flowing lacquers may be prepared in all viscosities.

THE application of a process using ozonised air in the baking of insulating varnishes is described in a paper by Messrs. L. U. Spence and P. B. Cochran, presented before the American Electro-Chemical Society. The time required for the drying of varnishes by this method is approximately 50 per cent. of the time required for baking in air. Standard tests on insulating varnishes baked in air and in ozonised air are tabulated and the results discussed. The tests are:—Time of drying, dielectric strength, water absorption, acidity, heat endurance and oil proofness. The results of tests show that the quality of the insulation produced by baking in ozonised air under the proper conditions is equally as good, and for some applications better, than the films produced by the slower process of baking in air.

WHEN the American Electro-chemical Society meets in October a paper will be presented by Mr. J. G. Thompson, on "The Materials of Construction for Nitrogen Fixation." In it he says that the chief features of the attack of the gases concerned on steels are represented by:—(1) Decarbonisation; (2) increase in combined nitrogen, principally in the chromium steels; (3) fissuring, voiding or porosity in the affected zones; (4) lowered strength and ductility. It was found that—(*a*) Carbon steels decarbonised and fissured readily; (*b*) nickel steels were deeply penetrated, but showed a high residual strength, explained by the presence of parallel longitudinal fissures aligned in the direction of stress; (*c*) chromium steels deteriorated rapidly if high in carbon, but were quite resistant if low in carbon; (*d*) tungsten and nickel reinforce the deterioration resistance of chromium steels if the latter are low in carbon.

Miscellanea.

A FACTORY for the fixation of atmospheric nitrogen is to be erected near Serada, on the Vah River, in Czechoslovakia.

ACCORDING to *La Vanguardia*, a deposit of some 40,000,000 tons of asphalt has been discovered near the coast of Samar, in the Philippines.

A HIGH-VOLTAGE electrical laboratory has recently been built at Stanford University in California to house apparatus with which experiments will be made using voltages up to 2,000,000.

THE Rumanian Government has undertaken to order at least 25 locomotives, 50 passenger coaches and 300 goods wagons a year from the new works that are to be put up at Bukarest.

THE Dominion Fuel Board has recommended that Federal assistance be given to the building of coke-oven plants, designed to use Canadian coal and provide a new outlet for Nova Scotian coal.

SOME new works, which are to cost "several million kroner," are to be put up by an Oslo firm for the synthetic production of ammonia by a process which is described as similar to the German Haber method.

A NEW rudder for the Cunard liner Berengaria is being made by the Darlington Forge and Engineering Company, but in the interval she is continuing to run with the damaged one that has been repaired.

AN early start is to be made on the construction of the Calgary and Southern Railway, which is designed to tap the coal reserves in the foothills west of Calgary, Alberta. Certain changes of route were authorised recently by the Legislature.

FINALLY revised statistics of the Canadian output of copper during 1925 show a production of 111,450,518 lb., which represents an increase of 6·7 per cent. during the year. The output of silver was 20,228,988 oz., an increase of 6 per cent.

ACCORDING to unofficial information, petroleum was recently discovered at Suncheongfow, Sunning, now known as Toishan, in the Kwangtung Province of China. A jet spurted out of a hole beside a grave. The villagers are now trying to exploit the discovery.

UNDER orders of the Government of India the complete reorganisation of the Survey of India into five circles has been effected. Each of the circles will be in charge of a director, but it is understood that these arrangements will in no way affect the Survey of India headquarters in Calcutta.

THE Chittagong Port authorities have formulated an extensive scheme for the development of the port, on which a considerable amount of work has already been carried out. A revetment scheme, which will cost some Rs. 20 lakhs, is nearly completed, and a new dredger has been ordered from England.

A PARACHUTE, 50ft. in diameter, which an engineer of the United States Navy has invented with the object of saving aeroplanes and pilots, was tested recently at Los Angeles. It brought an aeroplane to earth from an altitude of 2500ft. after the engine had been stopped. The machine, which came down on the side of a hill, broke a propeller blade, but otherwise the landing gear was undamaged.

SINCE the selling of Beira Port, Portuguese East Africa, to a new company known as Beira Works, Ltd., which was formed with a capital of £600,000, several important projects for enlarging and improving the port have been launched. The steel piling for the new wharves is being manufactured in Great Britain, and the actual constructional work at Beira will be done by Pauling and Co., Ltd., of 26, Victoria-street, London.

A MESSAGE from Madrid states that the Ministerio de Fomento has been authorised to invite tenders for the following:—(*a*) The lengthening and widening of the east mole and the adjoining quay of the Port of Alicante. The work is estimated to cost 8,151,578 pesetas; (*b*) the construction of quays on the jetties of the Port of Malaga, to cost 4,877,555 pesetas; and (*c*) the transformation of some of the quays of the Port of Tarragona, at an approximate cost of 2,750,562 pesetas.

COAL has, according to the *Iron and Coal Trades' Review*, been reached at a depth of 298 yards at the Upton pit of the Upton Colliery Company, Ltd., where sinking operations have been in progress since January last. Two shafts have been sunk, one at a depth of 298 yards, where the Shafton seam has been struck. The other is at present at a depth of 253 yards. The company expects to reach the Barnsley seam at the same depth as the Bullcroft Colliery, namely, 660 yards. The seam is 3ft. 3in. thick. The shaft is 21ft. in diameter, and is lined with concrete blocks.

A BILL to authorise the Canadian Dexter P. Cooper Company to generate power from the tides of Passamaquoddy Bay was passed by the Canadian Parliament before it was dissolved recently. The project provides for the development of 500,000 to 700,000 horse-power at a cost between 75,000,000 dollars and 100,000,000 dollars. A series of dams with navigation facilities is to be constructed between the islands from the coast of Maine to that of New Brunswick, the international boundary here running down the bay which separates Canadian from United States territory. The power-house is to be on the American side of the boundary.

IT is reported from Bogotá, Colombia, that the departmental authorities of Antioquia, having contracted with a German engineering firm for the construction of a modern port in the gulf of Uraba, the builders are to select the site for the port and start work immediately. The port will be connected with a highway, now under construction, from Medellin, about 150 miles from the Gulf of Uraba, and that is to be followed by the building of a railway. Engineers are now on their way to Colombia from Germany. The authorities state that the step was taken to eliminate the Magdalena River transportation difficulties. Prolonged drought often impedes or even stops all navigation on the Magdalena River.

CITY AND SOUTH LONDON RAILWAY—MORDEN EXTENSION

(*For description see page* 266)

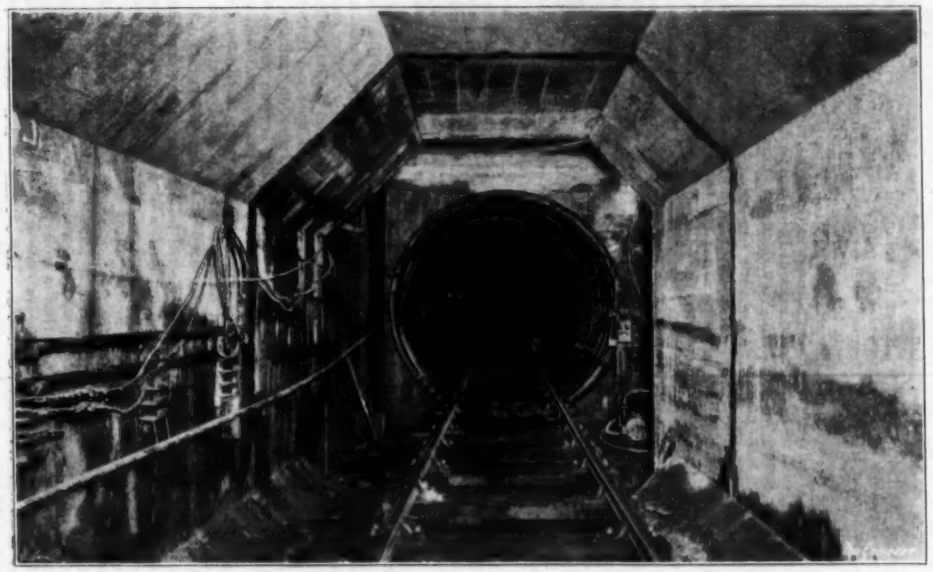


FIG. 28—JUNCTION OF IRON TUNNEL AND CUT-AND-COVER, DORSET ROAD

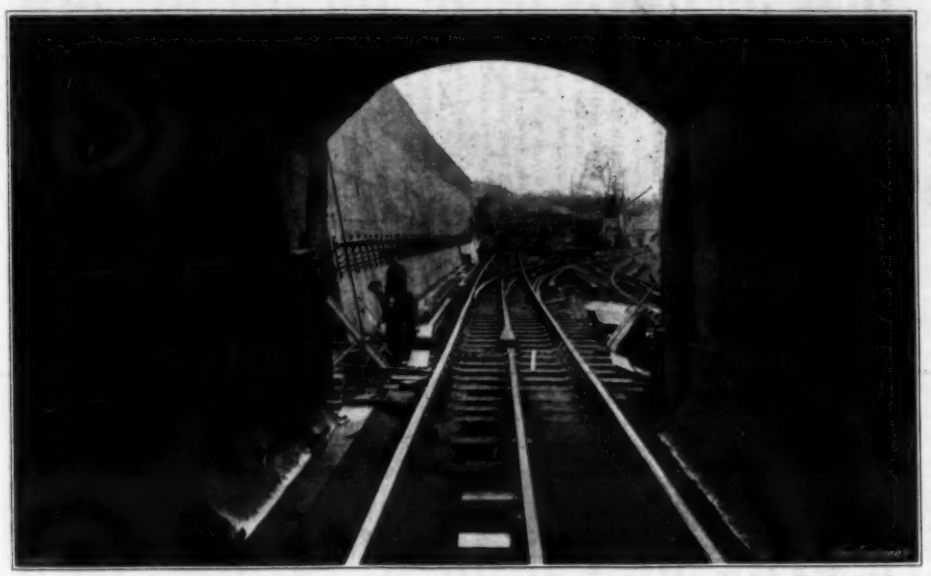


FIG. 29—END OF SOUTHBOUND CUT-AND-COVER TUNNEL NEAR MORDEN STATION

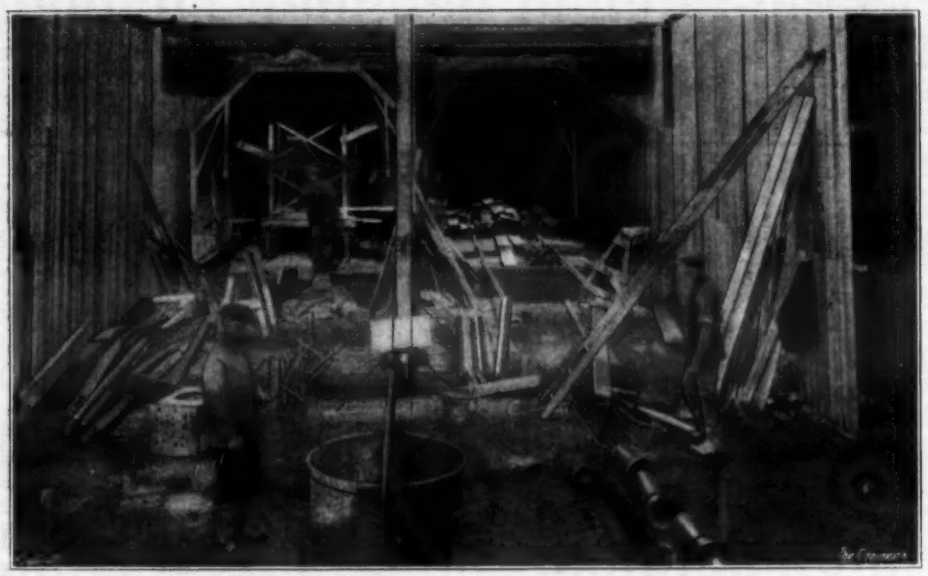


FIG. 30—CONCRETE CONSTRUCTION OF TWIN CUT-AND-COVER TUNNELS

FIG. 31—CUTTING IN APPROACH TO MORDEN STATION

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The Engineer

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THE ENGINEER.

SEPTEMBER 10, 1926.

The Shenandoah Disaster.

ALTHOUGH a year has passed since disaster overtook the United States airship Shenandoah, it may be doubted whether the full significance of that event is appreciated by those of the general public who take an intelligent interest in the development of aircraft. Full authoritative information on the loss has until quite recently been difficult to obtain, but with the receipt of the August issue of the *Journal* of the American Society of Naval Engineers we are placed in possession of all the technical facts elicited during the investigations of a court of inquiry appointed by the Secretary of the Navy to discover the cause of the disaster. The court's report is an admirably compiled scientific document, for the publication of which the whole aeronautical world must stand indebted to the United States authorities. Embodied in it is an unadorned record of courage and discipline which will hold the attention of even the least technical of readers to an extent beyond the capacity of any imaginative writer. The disaster is remarkable in many respects, and not least so in the fullness with which the events leading up to it can be reconstructed from first-hand personal and other evidence. When the ship left the Lakehurst mooring mast on the afternoon of September 2nd, 1925, she carried a crew of forty-three officers and men. In the disaster, which occurred in the early hours of the morning of the 3rd, five officers and nine men perished, two of the men were injured, and seven officers and twenty men escaped unhurt. From the detailed statements made by the survivors, from the barograph and other records recovered from the wreckage, and from miscellaneous knowledge gleaned after the event from a variety of sources, a very remarkable and consistent account of the technical aspects of the disaster, leaving little or nothing to be filled in by theory or guess work, has been compiled. In few instances is it possible to reconstruct a disaster with such certainty and completeness as in the case of the Shenandoah. When critically studied, the evidence leads to but one verdict. There is no question of an ill-found ship, of a captain persuaded to make a voyage against his better judgment, or of a criminal modification of the valve arrangement to save a loss of the precious helium with which the vessel was inflated. These and other allegations are shown to be naked falsehoods. The disaster was an inevitable accident, and was strictly analogous to that of a surface vessel overpowered by elements which no ship could be designed to withstand.

At 4.20 a.m. on September 3rd the airship, flying at about 1700ft. altitude, was making an air speed of 38 knots, with a ground speed of practically zero. Her set course had been departed from in order that she might avoid a severe thunderstorm. The storm was still in evidence at a considerable distance to the north, but ahead the sky was fairly clear. For some time the weather had been the subject of close observation and debate, but the change made in the course seemed to have removed any threat of danger. Yet a small cloud was observed to be building up rapidly ahead, and apparently to be approaching the ship. Scarcely had its possible meaning been discussed when the elevator man reported that the ship was rising, and that he could not check her. The vessel was being lifted very rapidly by a vertical current of air. Efforts were made to drive her nose downwards, but for about six minutes she continued to rise at an average speed of 225ft. a minute. During this period the automatic valves were discharging gas. The reduced buoyancy, combined with the downward drive, eventually checked the ascent, but instead of the vessel falling again, as was anticipated, it remained for some five minutes at something over 3000ft. Then a second rise developed. Neither the operation of the elevators nor the discharge of gas through the automatic valves or through the hand valves, brought into action to increase the discharge, could hold the ship down. As she rose, she pitched and rolled, and in the course of eleven minutes ascended to over 6000ft. A minute or so before the top of the rise was reached the hand valves were closed, and ballast was discharged, for it was again anticipated that with the decay of the vertical current the ship would begin to drop rapidly. The immediate effect was, however, to accelerate the upward rise to a rate of about 980ft. per minute. At the top of the rise the vessel, it was afterwards estimated, weighed 7300 lb. in excess of her buoyancy, and with the dying away of the vertical current she proceeded to drop, if not like a stone, then at something approaching the same speed. In three minutes she fell 3000ft. The rate of descent at first reached 1500ft. a minute, but was partially checked by the discharge of ballast. During the fall the barograph failed, but even had it survived it would have had little else to record. At 3000ft. the vessel's descent was checked, but within less than two minutes she began to ascend again, rolling and pitching violently as she did so. A very sudden upward inclination similar to that acquired by an aeroplane at the beginning of a loop was developed, and the sound of struts snapping was heard. Within a minute of the start of the third rise the airship broke into two parts. The control car shortly afterwards broke away from the forward portion and dropped to the ground with its eight occupants, all of whom were killed. At about the same instant the tail portion broke into two sections; one of which, originally the midship portion of the vessel, dropped directly, carrying its six occupants to their death, while the other, originally the tail portion, fell more slowly with twenty-two of the crew, all of whom escaped with their lives. Meanwhile the nose portion, freed of the weight of the control car, rose after the manner of a balloon, and with its seven occupants covered a distance of about 12 miles before it could be brought by skilled manœuvring to a safe landing. From the beginning of the first rise to the initial break in the structure just over half an hour elapsed. During that time the crew to a man struggled against their fate with a calmness and discipline unsurpassed in history. It is recorded that one of the officers, Lieut. Lawrence, was off watch and asleep in his bunk until he was awakened by the unusual motion of the vessel during the fall immediately preceding the final rupture. Of the Captain, Lieut.-Commander Lansdowne, it is said that throughout the period of uncontrolled movement he continued to issue his orders in a conversational tone. From the human point of view, we cannot but regret that this outstanding example of coolness and courage was not displayed on some object more worthy of it than, virtually, a showman's flight over the Middle-West States.

The cause of the disaster to the Shenandoah stands out like a beacon from the pages of the court of inquiry's report. She was destroyed simply and solely by the action on her of external aerodynamic forces of an unusual kind. She fell a prey to rapidly fluctuating vertical currents of air which were unaccompanied by any visible sign at present recognisable by meteorologists. In her design she closely followed standard practice abroad. Her constructon was in every respect sound. She was handled by a crew trained and experienced above the average. She did not fail,

as did our own airship R 38, because those who built her stretched their practice beyond the limits of safety indicated by current theory. She was a vessel in which were crystallised all the fruits of man's hard-won knowledge of the atmosphere and how to transport himself through it. Yet after a brief and gallant struggle she succumbed to unforeseen and apparently unforeseeable natural forces. She was like a surface vessel tossed out of the water by the violence of the waves, to fall again and again until fractured by the impact. To allow for the effect of such a condition has never entered the thoughts of the airship designer; it may be doubted whether, the possibility of the condition arising having been demonstrated, it will be found practicable to provide a structure of the bulkiness of an airship with strength sufficient to resist the accompanying shocks. It may be doubted whether any airship capable of rising off the ground could be built strong enough to surmount the forces which destroyed the Shenandoah. The airship is to-day as much a fair-weather vessel as ever it was. If the type is to be perpetuated without a recurrence of disasters such as that of a year ago, there would seem to be but one sure road to follow. We must learn how to read the signs of the weather with very much more certainty than at present, and be content to fly in airships only when the signs are favourable. In the opinion of many such a restriction on the flight of airships will no doubt be held, perhaps justly, to spell their doom as practicable means of transport.

French Naval Progress.

WITHOUT haste, yet without pause, the process of rebuilding the French Navy goes steadily forward. Not for a generation past has French shipbuilding policy proceeded on such definite and consistent lines. The practice of constructing experimental ships, each differing more or less radically from the other, which gave France a naval force not inaptly described as *une flotte des échantillons*, has been discarded. Instead, we are witnessing to-day the multiplication of vessels standardised in large groups according to type. More remarkable still, in view of former policy, is the laying down year after year of the quota of tonnage provided for by a long-term programme of construction. Paper shipbuilding projects designed to satisfy requirements for many years in advance are no novelty in France, but they have hitherto suffered mutilation with every change of Government. The Navy Law of April, 1922, differs from its predecessors in having been almost punctiliously adhered to for five years. Cabinets have come and gone, but the septennial programme survives, and there now seems every probability of its being completed to the last unit. Thanks to this uninterrupted flow of new tonnage, the French Navy is rapidly regaining its former position as a weighty factor in the balance of power at sea. So far as capital ships are concerned, it is, of course, restricted to a standard of strength which patriotic Frenchmen declare, and not without reason, to have been fixed without reference to the naval traditions and actual maritime responsibilities of their country. Nevertheless, their protests are somewhat vitiated by the fact that French professional opinion no longer accepts the capital ship as the supreme instrument of naval power. In this case, doctrine so far governs policy that no vessel heavier than a cruiser has been laid down since the war, nor have any steps been taken to replace the battleship France, which was wrecked in 1922, though the Washington Treaty expressly authorises the replacement of ships lost through accident.

To the building of vessels other than battleships and aircraft carriers the Treaty sets no limit. In the construction of cruisers, torpedo craft, and submarines, the signatory Powers are left with a free hand, and it is upon such light material that the French conception of naval strategy is based. The Navy Law of 1922, which has been amended only in minor details, provides for a total of 145 combatant ships. The fact that more than half of these are submarines attests the confidence of French experts in the power of the submarine arm. Flotilla leaders and destroyers to the number of fifty-seven are included, the balance of the programme comprising nine cruisers, a cruiser-minelayer, a training cruiser and two aircraft carriers. Clearly, therefore, the *guerre d'escadre* has little part in French naval calculations, in which the defence of the Mediterranean routes is the cardinal factor. Ignoring three old "Dantons," which are admittedly kept on the active list as a counterpoise to the German pre-Dreadnoughts, the present French fleet musters only six battleships, all of pre-war design. Three are armed with 12in. and three with 13.4in. guns. As they have all been extensively reconstructed, it would appear that the capital ship still has some partisans in France, even if their influence is not sufficiently strong to secure reinforcements for the battle squadron. The value of the nine cruisers included in the programme has excited much controversy, some critics condemning them as superfluous. In the report on the 1922 Navy Bill submitted to the French Senate, their functions were defined as follows:—"(1) To protect destroyers and torpedo-boats against the intervention of enemy scouting ships; (2) to clear the sea of enemy destroyers and torpedo-boats; (3) to ensure regular intercourse with the French colonies." We are tempted to remark that, by substituting "cruisers" for "destroyers and torpedo-boats" in the foregoing definition, an equally strong case might be made out for the building of capital ships. Cruisers can neither afford protection to their own mosquito flotilla nor maintain communication with oversea territories unless they are themselves protected from the interference of enemy ships of greater power, and such protection can only be given by capital ships. That, however, is by the way. In a recent edition of "Brassey's Annual," Captain Delpierre, of the French Navy, strongly opposed the building of cruisers, arguing that they were useless as a defence for troop convoys and were not required as scouts for a battle squadron, which in a few years will be virtually non-existent. "France," he concluded, "will regain her rank among the naval nations of the world only when she has succeeded in building powerful submarine and aerial fleets. It is only then that she will be in a position to defend herself, for she has never dreamt, and will never dream, of being the aggressor. Logically, there is no room in such a programme for light cruisers." The fact remains that three cruisers of 8000 tons and six of 10,000 tons are to be completed by 1931, and it is not difficult to imagine circumstances in which these vessels would be of great value, though not, perhaps, in a campaign confined to the Mediterranean area. In developing the new torpedo flotillas, France has avoided her former mistake of building craft which were only formidable in smooth water. Diminutive "torpilleurs" have given place to large vessels of robust construction, high freeboard and ample engine power. The first six flotilla leaders to be put in hand—"Chacal" class—displace 2400 tons; in the next three ships, now on the stocks, the displacement has been increased to 2700 tons, and the further units to be laid down this year will be of 3100 tons. Such vessels should be able to cruise and fight in weather which no ordinary destroyer could face, and their armament of five or six 5.1in. guns of the latest high-velocity mark would render them dangerous antagonists, even for a small cruiser. France will eventually have twenty-one of these powerful craft, which in spite of their high cost are regarded as the most valuable surface ships of the new navy. The destroyers also, of which thirty-six are to be built, are large weatherly vessels of 1500 tons, mounting four 5.1in. guns. The new submarine fleet, consisting of 75 boats, is divided into five classes, viz., submarine cruisers, large ocean-going boats, medium ocean-going boats, coast defence boats, and minelayers. The first of the submarine cruisers is to be laid down this autumn, the surface displacement being given variously as 3000 and 3500 tons. In either case the vessel will be larger than the British X 1 and will probably surpass even the latest American "V" boats. The utility of such heavy submarines is as yet entirely speculative. In this country no attempt has been made to repeat the X 1, which seems to be something of a white elephant, and in deciding to build a submarine of unexampled tonnage the French Government has probably deferred to public rather than to naval opinion. The large ocean-going boats are of 1500 tons, the next class being 400 tons lighter, the two groups numbering collectively thirty-six units. The thirty-one coastal submarines contemplated are apparently of uniform design, with a displacement of 600 tons. Six mine-laying boats, details of which are not yet to hand, complete the imposing list of underwater craft. All these new submarines have been designed on the basis of war experience, and after a careful inspection of the surrendered German boats. While it is not to be supposed that French constructors, whose skill and ingenuity are proverbial, have been content to copy slavishly any foreign model, there is little doubt that certain meritorious features of German construction have been embodied. Special importance is attached to motor reliability, and judging from the prolonged endurance cruises already made by some of the new boats, French post-war submarines are equipped with thoroughly reliable engines. Their offensive powers have been increased by the adoption of the 21.7in. torpedo, a more formidable weapon than the standard torpedo of the British Navy.

All the vessels enumerated above, from cruisers to submarines, are scheduled to be in service by the year 1931, but that the programme will be fully completed by that date is rather doubtful. The first of the cruisers and destroyers are already behind time, and it is possible that the financial crisis may interfere with the punctual laying down of new tonnage projected for the next two years. Even so, however, there are enough vessels actually under construction to ensure the presence in the Mediterranean of a powerful French fleet at a comparatively early date. While this new fleet of speedy, well-armed ships and efficient submarines may not be sufficiently powerful to guarantee the immunity of the Franco-African sea routes under all circumstances, its presence would render an attack on those routes a very hazardous proceeding, particularly in view of the strong air forces which would be available for co-operation with the naval defence. It would seem, therefore, that the prime objective of current French naval policy is within sight of attainment.

Literature.

SHORT NOTICES.

Electrical Contracting. By H. Ayres Purdie. London: Ernest Benn, Ltd. Price 10s.—As far as we know this is the first book that has been written on electrical contracting, and it should, we think, meet the requirements of many who are engaged in electric wiring and kindred work. It does not contain a vast amount of theoretical information or abstruse calculation and formulæ, but it, nevertheless, gives a good deal of information that is of value to electrical contractors. In the early part of the volume the author deals with business essentials and gives many useful hints on the way in which an electrical contracting business should be conducted, how capital may be raised, and so forth. Considerable attention is paid in a subsequent chapter to the question of advertising. Coming to the more technical side of the business, the author goes on to deal with plans and sketches, specifications, estimates, &c., rules and regulations governing the installation of electrical machines and apparatus, wiring systems, illumination, and general installation work. Considerable space is devoted to the installation of electric motors and the application of electric power to different industries. The book also deals with electric bells and circuits and miscellaneous applications of electricity. On the whole the author has covered his subject well and has provided a book of a rather unique character.

The Brassfounders' and Finishers' Manual. By Philip Gates. London: Crosby Lockwood and Son. 1926. 5s. net.—A most useful little book, full of practical hints, not, of course, intended to give a full exposition of these arts, in which manual skill forms such an important asset, but giving enough information to save the beginner from many pitfalls. The book covers patternmaking, alloying, foundry work, fettling, finishing, polishing, lacquering, &c., and soldering. In the section devoted to finishing there is much good advice as to the use of both hand and machine tools, while a number of recipes are given for colouring and bronzing.

The Efficient Boiler House. By J. J. Simmons. London: Crosby Lockwood and Son. 1926. 5s. net.—This is a practical little book containing much information of guidance to those in charge of boiler-houses, but it does, perhaps, suffer to some extent in concentrating on some makes of plant to the exclusion of others. It is divided into a dozen chapters which deal respectively with operating the boiler-house, flue gas analysis, boiler-house equipment, modern instruments, the Bailey boiler meter, the Econometer CO_2 tester, superheated steam, Green's economiser, care of the feed water, regulating the feed, the furnace and coal analysis.

BOOKS RECEIVED.

Annales des Travaux Publics de Belgique, Août, 1926. Brussels: Goemaere, 21, Rue de la Limite.

Report of the United States National Museum, 1925. Washington: The Government Printing Office. 1926.

The Journal of the Worcester Polytechnic Institute. July, 1926. Published by the Alumni Association of the Institute, Worcester, Mass., U.S.A.

Proceedings of the American Society of Civil Engineers. Part I., August, 1926. Published by the Society, 33, West Thirty-ninth-street, New York.

Institution of Civil Engineers: List of Members and Addresses, Corrected to July 1st, 1926. Published by the Institution, Great George-street, Westminster, S.W. 1.

Eighteenth Annual Report of the Hydro-Electric Power Commission of the Province of Ontario for the Year Ended October 31st, 1925. Toronto: Clarkson W. James, Printer to the King. 1926.

Annali dei Lavori Pubblici, già Giornale del Genio Civile (Ministero dei Lavori Pubblici, Consiglio Superiore), Anno LXIV. Giugno. 1926. Rome: A. de Gaetani, Via Torre Argentina, 47.

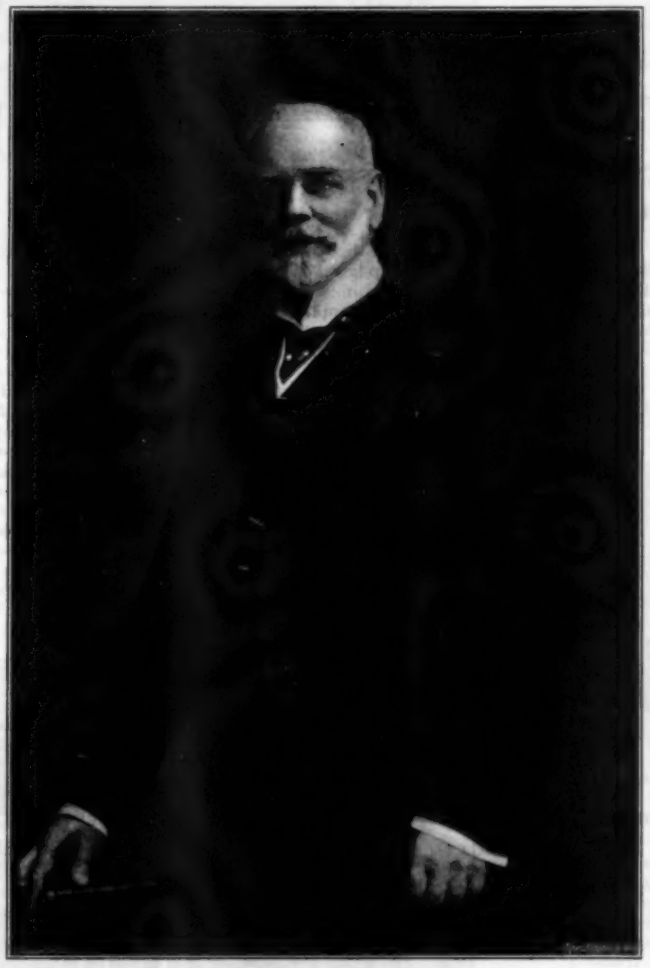
Obituary.

WILLIAM HENRY ALLEN.

THE death of Mr. W. H. Allen, which occurred at an early hour in the morning of September 3rd, is one of those inevitable events which seem to break the continuity between the great past and the present. For whilst it is true that Mr. Allen maintained close contact with the business he had built up and with the engineers of to-day, yet he belonged to a former generation, a generation in which character was developed—frequently by hardships—at an early age and in which young men did things which older men fear now to attempt. The passing of such men, men who bind the present with the pioneering days of engineering, holds something more than grief for a departed friend. It ruptures a tie with other times and other manners and snaps yet one more of the cords that bind us to the illustrious past. Mr. Allen was born in 1844, a time when technical education was almost unknown, when engineers learnt their art and craft by practical experience, and when men were expected to take positions of responsibility almost as soon as they came of age. Unsuitable as that system would be for present conditions, it had great merits. At an early age it built up, in those that had the necessary qualities, a strength of character, courage, and self-reliance which the leading strings of prolonged education seem, if anything, to check.

When he was no more than nineteen years of age Mr. Allen became a works owner, for his mother bought him an old foundry and forge in Cardiff, his native city. He had served his apprenticeship, no doubt beginning as a mere boy, with Richard Neville and Co., of Llanelly, who, at that time, were amongst the leading makers of colliery steam engines. To jump from apprenticeship to ownership when he was still, in a legal sense, an infant, showed not only great courage upon his part, but upon that of his mother. But he took upon himself a still further responsibility, for he had hardly started in the works when he married. We of to-day are astounded by the daring of that day—works owner and married before one and twenty! He carried on his little works, we may guess, with courage and enterprise, for several years. But his ambitions were unsatisfied. The foundry and forge in Cardiff did not offer him the scope he wanted, and in 1869 he disposed of the works and took his way to London. We had it from his own lips some years ago that it was a report in this paper of a lecture at the Royal Institute which gave the last impulse to his resolution to leave Wales. He wrote to several firms in London, offering his services, amongst them Gwynnes. The replies were all unfavourable, but a few days later Gwynnes wrote to say that they had lost their manager and would be glad to see him. He hastened to London, waited some time to see Mr. Gwynne, and as a result of that interview was engaged. He remained as general manager at the works in Essex-street, Strand, for eleven years. In a very short time he gained great influence in the firm, but when two very determined characters meet a difference of views is likely enough to lead eventually to their parting company; and so it happened in this case. With his own savings and those of a friend, Mr. Allen established a little works in York-street, Lambeth, close to the London and South-Western Railway. The site may be regarded as a lucky one, for not only was the reputation of the firm built up upon it, but in the course of a few years the railway company found it desirable to purchase it. Mr. Allen was not loth to sell, for he wanted still more scope; he wanted bigger and better shops and he wanted better accommodation for his workpeople than could be found in a crowded part of London. So he sold his works and moved, lock, stock and barrel, to Bedford. That was in 1894.

Great as have been the progress and development of the works since their removal to Bedford, the foundations of that success were laid by Mr. W. H. Allen in the fourteen or fifteen years spent in Lambeth. It was there that he developed the "Allen" high-speed steam engine and the "Conqueror" pump, and by his energy, his striking personality, and his keenness about everything built up invaluable connections in many parts of the world and established friendships in naval and shipbuilding circles which eventually led to that connection with marine engine auxiliaries which the firm enjoys to this day. As an example of his provision we may recall that as long ago as 1883 he associated himself with Dr. Gisbert Kapp, who designed a dynamo which could be coupled direct to an Allen engine for the generation of electricity for lighting aboard ship. The first Allen-Kapp set was fitted in the old twin-screw battleship Devastation, built in 1870, for experimental purposes and worked with steam at a pressure of 11 lb. In the following year a set was shown at the Inventions Exhibition. The engine and dynamo were on one bed-plate and the complete set weighed 3 tons. The success of this combination was so complete that the employment of sets of the kind became regular Admiralty practice. In other directions, also, the Allen engine became popular afloat. It had already been used for driving centrifugal service and salvage pumps direct, but by degrees it was adopted for circulating pumps and then, as forced draught came into use, for driving fans. It is of interest to note that the firm has never lost touch with this marine side of its business, but has continued to advance with its development and now produces steam turbines and oil engines to perform the same services which the original Allen engine performed in the 'eighties.



WILLIAM HENRY ALLEN

In 1889 the first important change in the constitution of the firm was made. Up till then Mr. W. H. Allen had retained sole control, but in that year he decided to take into partnership Richard, his eldest son, and the title of the firm was changed to W. H. Allen, Son and Co.; in the following year it was converted into a limited liability company, Mr. Harold Gwynne Allen and Colonel P. B. Crowe being appointed directors. A little later, another son, Rupert, was also elected to the board, and in 1920 the style of the firm was again changed, this time to W. H. Allen, Sons and Co., Ltd. All through this long period Mr. W. H. Allen remained chairman, and until increasing weakness made it impossible for him to do so he took an active part in the affairs of the company. Since he was of a very firm and masterful disposition, little or nothing was done without his direct sanction and approval. He seemed never to cease from work, yet did not spare himself from public and semi-public duties and managed to find time for travel, for the collection of pictures and books, and for playing a very fine organ which he had erected in his house. Amongst his public duties we must not forget to record that he was a magistrate, that he served as High Sheriff of Bedfordshire in 1904—a high post in which he has been followed by two of his sons, Richard and Harold—and that he was Deputy Lieutenant and a member of the Territorial Association. Amongst his semi-public duties—that is, duties to his profession—his services to the Institution of Mechanical Engineers deserve to be particularly remembered. For several years he was a vice-president and would certainly have been president had his health permitted. On the Council his experience was of the utmost value on all matters, but there was no branch of the Institution's work into which he threw himself with more zeal than that connected with the progress and education of young engineers. He was a very ardent believer in technical and scientific education and particularly in university training, and only a few years ago he gave the sum of £1000 to enable a young man, who was to be selected by the Council of the Institution, to spend three years in the Engineering School at Cambridge University. The success of that generous gift was amongst the great pleasures of his declining days. The Institution owes to him, also, the foundation of its Benevolent Society, which has done much for members and the families of members who have fallen upon evil days.

His constant thought for the coming men of the profession found full scope in the great works at Bedford, where he was able to develop schemes that were impossible in London. He was amongst the first to systematise the training of apprentices and pupils, to appoint a director of studies, and to set up a technical class room in the works. The success of the plan is proved by the large number of men in all branches of life who have been trained successfully at Queen's Engineering Works. With his old pupils he loved to maintain contact and for many years was always to be found as the most honoured guest at the annual dinner of the Pupils' Association.

In another direction, too, he exhibited this human side of his professional life. The welfare of his employees had always been very near to his heart, and to celebrate the twenty-fifth birthday of the company he presented it with the Allen Institute; he gave, also, generously to the Church School and contributed largely to the building of All Saints' Parish Church, which will always be associated with his name. Many examples can be found in this country of the influence which the enterprise, courage and character of a single man has had upon large numbers of his fellow subjects. But the development of Bedford as a result of the establishment of the Queen's Engineering Works there is an exceptionally clear-cut example. It became evident some years ago that the town could not accommodate the increase of inhabitants which the growth of the works necessitated; a new residential area, close to the works was needed, and into its development Mr. Allen threw himself with customary energy and generosity. Queen's Park, where over 5000 people are accommodated, many of whom are employed either at the Queen's or the Biddenham Works of the company, may justly be regarded as the direct outcome of the removal of the firm from London to Bedford.

It was impossible to come into contact with Mr. Allen even for a sort time without being impressed by his strong personality. His character was of the firmest; quick to form a decision and resolved to achieve it, he did not readily brook opposition, yet he bore a large and kindly heart, particularly to young men, and there grew up around him a great number of men who loved him as much as they respected him.

On account of certain physical characteristics it possesses the metal beryllium is, according to Mr. V. L. Eardley-Wilmot, adaptable for special uses in electrical and physical apparatus. The metallurgical difficulties involved in the commercial extraction of the metal from its ores have prevented to a great extent a larger use of the metal. The remarkable properties of beryllium have in the last five years been more fully recognised, and increased attention has consequently been devoted to the metallurgical problem. More economical methods that will lower the cost of the metal and its salts have been discovered, and will permit of their use in various ways that hitherto have been prohibitive on account of expense. Considerable deposits of the mineral occur in Ontario.

The Wireless Exhibition.

THE first National Radio Exhibition was opened at Olympia on Saturday, Sept. 4th, and will close on the 18th. Although there is no evidence of anything exceptionally new or startling in design and results, the Exhibition includes examples of the finest receivers and components that have so far been produced, and a full-size replica of the main Savoy-hill Studio from which the "2 L O" transmissions emanate. During the Exhibition many of the London transmissions are being made from this studio at Olympia, thus enabling visitors to gain an idea of the methods of broadcasting. The exhibit is situated in the gallery of the new hall, and the whole of one side of the studio and control room is composed of plate glass, thus

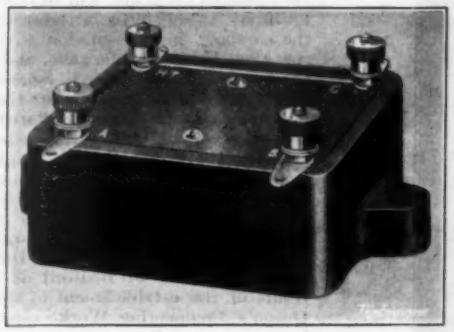


FIG. 2—RESISTANCE CAPACITY COUPLING UNIT

enabling visitors to see exactly what happens when artists appear before the microphone. Passing along the gallery to the control room, visitors can see the control engineer holding the two knobs which control the electrical equivalents of the sounds passing over the land lines to Savoy-hill, and thence to the transmitter. Small instruments placed in front of him give an indication of the maximum he must not pass

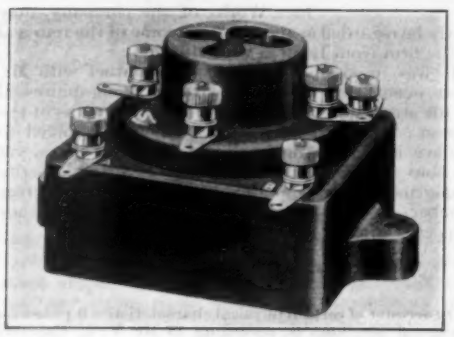


FIG. 3—COUPLING UNIT AND VALVE HOLDER

and the minimum he must not fail to supply. This exhibit of the British Broadcasting Company is arousing a considerable amount of interest, and it is said that during the broadcasting of a revue, when some of the most popular B.B.C. artists were to be seen in the flesh, a queue which stretched round a large part of the gallery, and which at one time included no fewer than a thousand people, waited to pass before the glass windows. Visitors have an opportunity of seeing the two types of microphones used in the studio—the standard magnetophone and the new type of microphone with which the British Broadcasting Company is now experimenting.

One of the new exhibits of Radio Instruments, Ltd., of 12, Hyde-street, New Oxford-street, W.C. 1, consists of a pair of transformers for power valves connected as shown in the diagram—Fig. 1. The arrangement works on the "push-pull" system, and

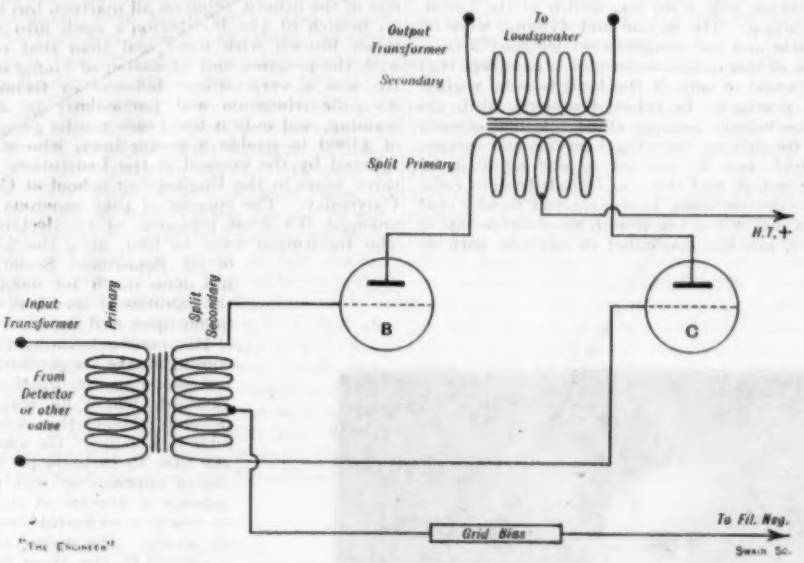


FIG 1—"PUSH-PULL" TRANSFORMER CONNECTIONS

as the power is split up between two valves a balanced and distortionless circuit is claimed to be obtained. Although considerable amplification is secured the use of special valves is unnecessary, even when large powers are being dealt with. The transformers are made in pairs. The first, which is called the input transformer, has one primary and two secondary windings, which are accurately balanced, whilst the second, known as the output transformer, has two accurately balanced primary windings and one secondary winding. There are therefore five terminals on each transformer instead of four, and as will be gathered from the diagram, the two amplifying valves work together as one, the output from the ordinary valves or detector circuit being connected to the primary of the input transformer. The energy is split and divided equally between the split winding of the second or output transformer, the single secondary passing on the united effect to the loud speaker. Only half the total energy is amplified by each valve, with the result that there is less possibility of the valve becoming saturated. The makers point out that any defects in the potential supplied to the grids of the valves which might be caused by differences in the iron used in the construction produces no effect upon the output, because these differences make themselves felt on both grids simultaneously and one defect balances out the other. Ordinary valves can be used instead of power valves, and the circuit is claimed to be particularly economical as regards high-tension current. Another advantage is that as there is no direct-current output in the second transformer, it is unnecessary to pay attention to polarity when connecting up the loud speaker.

Among the new wireless components exhibited by Metro-Vick Supplies, Ltd., of Trafford Park, Manchester, is a resistance capacity coupling unit, as shown in Fig. 2, which, in conjunction with the Cosmos S.P. 18/B (blue spot valve) can be used when constructing a new receiving set, or it may be employed to replace a low-frequency transformer and general-purpose valve in an existing set. The makers claim that this component, together with a blue spot valve, will form a stage of low-frequency amplification equal to the usual transformer stage, and that pure reproduction is obtained at approximately half the usual cost. Although the coupling unit has been primarily designed for use with Cosmos blue spot valves, it

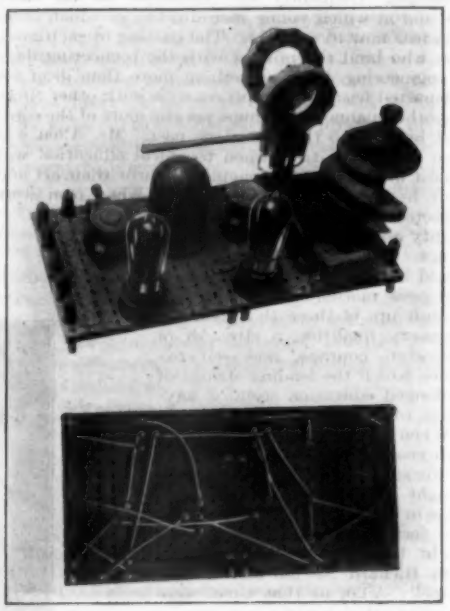


FIG. 4—"BLACKADDA" RECEIVER

may be used with any valve having an amplification factor of 30 or more, the amplification factor of the Cosmos S.P. 18/B valve being 35. Other advantages claimed for this system of amplification are economy in high-tension battery current, the anode current of the S.P. 18/B valve being less than one-twentieth of that required by valves generally employed with transformers or chokes. Moreover, the blue spot valves only take a filament current of 0·09 ampère at a pressure of 1·6 to 1·8 volts. The coupling unit is made in two types, namely, with or without the firm's spring valve holder, as shown in Fig. 3.

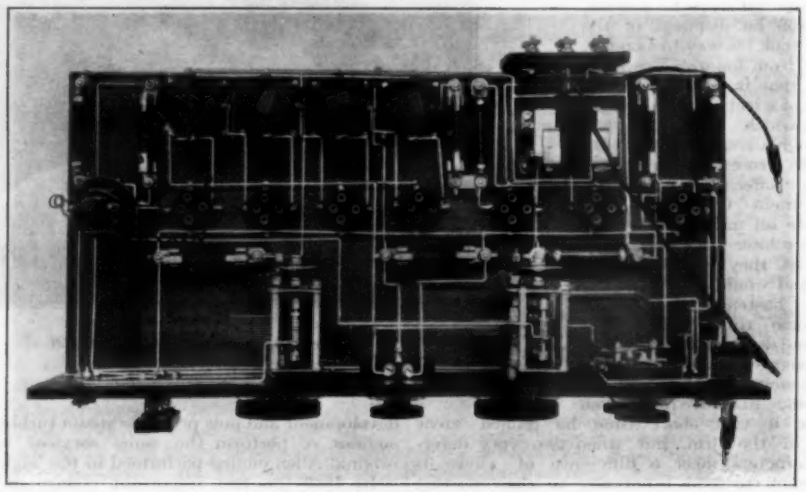


FIG. 5—SUPERSONIC HETERODYNE RECEIVER

A system of building wireless sets which is of interest to experimenters is being shown by the Blackadda Radio Company, of Sadler Gate, Derby. It enables the amateur or the advanced experimenter to set up circuits of a simple or elaborate nature, and to vary and extend them with little trouble. All the components are standardised as regards terminal points, so that they will fit into a table or base which consists of a moulded panel having 140 equally spaced holes, which are numbered on each side, the panel being supported by four corner legs. The components fit into the numbered holes and are secured in position by nuts on the back of the panel. The wiring is carried out by means of special connectors, which consist of insulated flexible wires supplied in six standardised lengths, and provided with terminal loops, which are slipped over the terminal posts and secured by means of the nuts, as shown in Fig. 4. Instruction sheets issued by the Blackadda Radio

Company indicate in which holes the various components should be placed, and how the wiring should be carried out on the underside of the panel where the holes are also numbered, thus making it an easy matter for the experimenter to wire the set up in accordance with the instructions. The connectors vary in length and each has a different coloured insulating covering. For the benefit of those who already possess wireless components and who do not wish to discard them, the makers supply an adapter, which consists of a small four-connection point base, suitable for accommodating such apparatus.

Notwithstanding the relatively high cost of the supersonic heterodyne wireless receiver, this type of apparatus is very prominent at the Exhibition. Many firms are showing receivers of this type, and some of them are very elaborate. The Igranic Electric Company, Ltd., of 149, Queen Victoria-street, is exhibiting a new and interesting portable receiver of this description, and at a private hotel a short distance from the Exhibition the performance of the receiver, is being demonstrated. At the time of our visit distant stations were received with ease. The receiver which is also to be seen on the company's stand in the Exhibition, is enclosed in a leather case, and a similar case contains the batteries. It is well known that the Igranic Company also supplies a complete set of component parts for a six-valve supersonic heterodyne receiver, which is a much larger piece of apparatus, but we understand that the new portable receiver is only supplied complete, as it is considered that its construction is beyond the capabilities of the average amateur. The frame aerial used with the portable supersonic heterodyne receiver is of the collapsible type, and is also supplied separately for use with other receivers. It is provided with a counter winding, and when used with supersonic heterodyne receivers built in accordance with the Igranic Company's designs is claimed to eliminate interference caused by stations sending out signals at

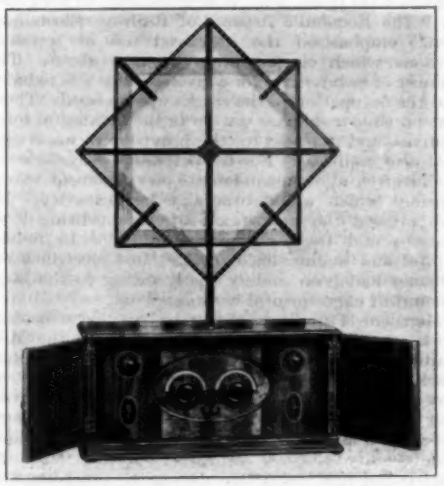


FIG. 7—"ETHODYNE" SUPERSONIC HETERODYNE RECEIVER

a frequency approximating the intermediate frequency of the receiver. The two windings of the frame aerial are separate, and are connected to four terminals on the base, so that the windings can be connected in various ways to cover different wave lengths, but the advantages of the counter winding are obviously not obtained when the windings are connected in series.

Since the Exhibition held at the Albert Hall last year the McMichael seven-valve supersonic heterodyne receiver, shown in Figs. 5 and 6, has undergone certain improvements. The lay and wiring is still in accordance with the blue print issued with the set of parts, but Dimic coil clips are now fitted to the panel to the right of the loop terminals, so that a loading coil, which is a Dimic No. 2A coil, can be inserted for loading purposes in order that when working with a British broadcast frame aerial the wave length of the set can be increased to that of the Daventry and Radio Paris stations. Two filament switches are now also supplied, one for the detector and low-frequency stages and one for the autodyne and intermediate valves. The principle of the set is fully described in a brochure which can be had on application at the company's stand. In a supersonic heterodyne wireless receiver there are various ways of generating the local oscillations, and in the receiver under consideration an endeavour has been made to economise in the use of valves and to increase efficiency by making the first detector operate as an oscillating valve as well, in accordance with the autodyne system.

The Ethodyne receiver—see Fig. 7—made by Burndept Wireless, Ltd., of Blackheath, is an improved model of the seven-valve super-heterodyne receiver produced by the firm during 1925–1926. The size of the cabinet has been slightly reduced, and

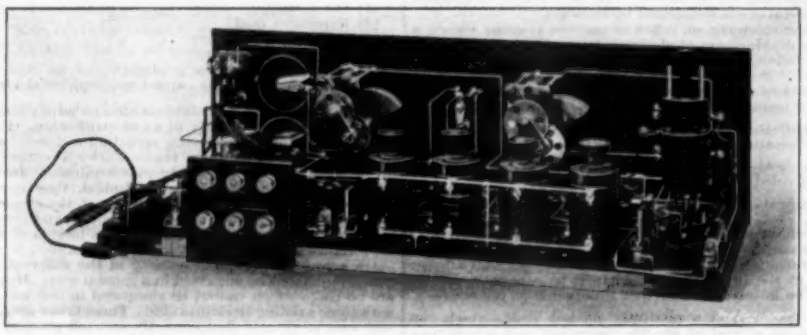


FIG. 6—REAR VIEW OF SUPERSONIC HETERODYNE RECEIVER

the low-frequency end of the set has been re-modelled. There is now a low-frequency stage with a resistance capacity coupling, and one with a Marconi Ideal transformer coupling. This alteration in the design is said to have increased the volume and to have resulted in much better reproduction. The most important change that has been made in the design of the set, however, is the provision of rejector windings on the frame aerials, which are made in accordance with the Willans patents, the object of the rejector windings being to suppress interference from long-wave stations. Provision has been made for the use of reaction on the short and long wave frames, and it is no longer necessary to use a special valve for the first detector. The model illustrated is known as the Ethodyne de Luxe. To the long list of firms supplying super-heterodyne components, Burndept Wireless, Ltd., may now be added. A super-heterodyne transformer made by this firm is shown in Fig. 8. Sets of matched transformers are supplied, together with other components and full instructions for making a seven-valve super-heterodyne receiver. The transformers are enclosed in a heavy brass case, which gives complete shielding.

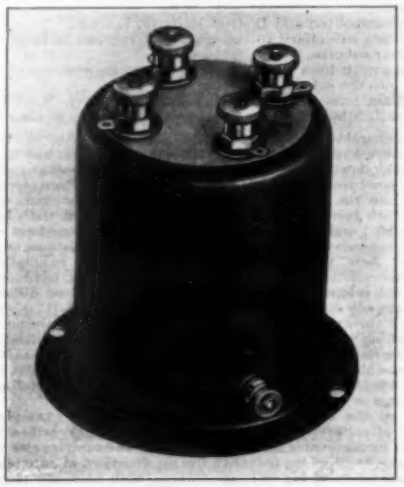


FIG. 8—TRANSFORMER FOR SUPERSONIC HETERODYNE RECEIVER

The General Electric Company, of Magnet House, Kingsway, has a good display of supersonic heterodyne components, any of which can be purchased separately. Frame aerials shown on the company's stand are particularly suitable for use with supersonic heterodyne sets, and are designed to take the company's "Gecophone" plug-in coils for extending the wave length. The company is also showing a new and complete range of receiving sets, and a large collection of valves, high-tension battery eliminators, &c. Similarly, the British Thomson-Houston Company is exhibiting a complete range of its wireless products, comprising crystal and valve receivers, headphones, loud speakers and transformers. On a separate stand this firm shows eleven types of B.T.H. valves—four general purpose, four power amplifying, two high frequency and a detector valve.

Many firms are exhibiting high-tension supply units designed with the object of eliminating the high-tension battery, which is undoubtedly one of the most expensive items connected with wireless receiving sets. Among these firms is the Marconiphone Company, Ltd., of 210–212, Tottenham Court-road, which is showing an instrument contained in a case, with a nickel-plated carrying handle and a flexible lead and plug for connecting the apparatus to an ordinary lamp socket. There are four shrouded terminals, one negative and three positive, allowing for the supply of current at 42, 84 and 126 volts. There is space in the case for a Marconi U.S. rectifying valve, which is inserted through the bottom of the apparatus. By altering the connections on the terminals of the transformer, the instrument may be used with pressures in the neighbourhood of 100 or 200 volts. The filament of the rectifying valve is heated with alternating current taken from a special winding on the transformer within the instrument. Biphase rectification is employed in order that the maximum efficiency may be secured.

Selectivity is now a matter of considerable importance in the design of wireless receivers, and many of the receivers and components shown at the Exhibition have been designed to secure it. The British Radio Corporation, Ltd., of Weybridge, for example, is showing a high-frequency combination neutralised transformer, specially designed for neutrodyne circuits, and it is claimed that this transformer represents the very latest improved method of radio frequency amplification with the extreme simplicity required under present conditions.

The practice of shielding all the vital high-frequency and aerial coils in copper cases and earthing these cases appears to be gaining favour, and one of the firms exhibiting copper cases for this purpose is Peto-Scott and Co., Ltd., of 77, City-road, E.C. 1. The difficulties of obtaining stability when more than one stage of high-frequency amplification are employed are well known to wireless experimenters, who frequently find it no easy matter to avoid their sets bursting into oscillation. Much of this instability frequently arises from the interaction between high-frequency coils and the aerial coil, which throw out strong magnetic fields. But by placing each coil in a separate metal case and by connecting the cases to the earth lead of the set, considerable improvements have been obtained. Sets provided with these copper cases are said to become astonishingly selective. We are told, in fact, that with the "Five Fifteen" set, which is a typical Radio Press receiver, provided with copper cases made by Peto-Scott and Co., Ltd., 2 L O can be cut out at a distance of a mile and a half, this being partly attributable to the entire absence of a "direct pick up" on the coil itself. Although almost any metal will act as a shield, the makers of these shields have strong reasons for using copper, which, of course, is a very good conductor. Another point which visitors to the Exhibition can scarcely fail to note is the tendency to simplify the control of receivers and to reduce the number of adjustments to a minimum. Several condensers are now frequently coupled together and actuated by a single knob. Still another tendency revealed is that of replacing high-tension dry batteries by high-tension accumulators, which are to be seen on many of the stands, including that of the D.P. Battery Company, the Hart Accumulator Company, Rotex Motor Accessories, Ltd., the Tungstone Accumulator Company, the Chloride Electrical Storage Company, C. A. Vandervelle and Co., and others.

The World Power Conference at Basle.

No. I.

THE first World Power Conference, held at Wembley in 1924, under the auspices of the leading technical institutions, was the outcome of a desire for a fraternisation and an exchange of views on professional subjects amongst the hundreds of engineers from all parts of the world who had come to visit the Exhibition. It is no secret that the success of the Conference was mainly due to the organising powers of the British Electrical and Allied Manufacturers' Association, which, realising the advantages of friendly intercourse amongst the engineers of all countries, set itself to overcome the difficulties of language, &c., and to provide a programme of papers and visits both useful and enjoyable. The World Power Conference filled such an obvious need that the organisation took a permanent form, and advantage has been taken of the present International Exhibition of Inland Navigation and the Utilisation of Hydraulic Power at Basle, which was described in our issue of July 16th, 1926, to hold a sectional meeting of the Conference for the benefit of the large number of engineers visiting the Exhibition. The aim of the sectional meeting, which lasted from August 31st to September 8th inclusive, was to continue the task of the first World Power Conference so far as the promotion of personal intercourse between the technical and financial experts of all countries is concerned, and also to provide opportunities for a thorough discussion of subjects likely to be of special interest

to those visiting the Exhibition. The importance of the sectional meeting is indicated by the fact that no less than thirty-two different countries sent official delegates, and the participants in the Conference numbered nearly six hundred. Germany made the biggest individual contribution to the number, with 117 representatives, while the British representatives numbered 31.

The local organisation, which was in the hands of the Swiss National Committee, presided over by Dr. Edouard Tissot, was in every way effective, and the indefatigable courtesy of Dr. Carl Huebscher, the organising secretary, played a large part in promoting the comfort and contentment of all the visitors. The linguistic ability of the whole of the Conference staff was another element in the success of the Conference, and the work of the official interpreters at the meetings was really remarkable. German, French and English speeches on technical subjects were instantly rendered into the other two languages as fully as, and sometimes even more fluently, than the original speaker had delivered them in his native tongue. The technical programme consisted of no less than eighty-four papers, classified under five groups and for each group a Swiss "sectional reporter" was appointed, whose duty it was to summarise the various papers of the group in a manner to facilitate discussion. Group A, relating to "The Utilisation of Water Power and Inland Navigation," had indeed two reporters, Monsieur E. Payot, director of the Basle electricity works, who dealt with twenty-three of the reports, and Dr. A. Strickler, of the Berne Water Research Institute, who summarised the other twenty of this group. Professor J. Landry, of Lausanne, was the reporter for the six papers in Group B, on "The Exchange of Electrical Energy between Countries;" Dr. A. Nizzola, president of the Motor-Columbus Company, of Baden, summarised the thirteen papers in Group C, on "The Economic Relation between Electrical Energy Produced Hydraulically and Electrical Energy Produced Thermally." Section D, with nine papers, was devoted to "Electricity in Agriculture," the reporter being Monsieur F. Ringwald, director of the Central Swiss Power Works at Lucerne; while Section E, with its thirteen papers on "Railway Electrification," was summarised by Dr. E. Huber-Stockar, Chief Engineer of the Electrification of the Swiss Federal Railways.

The meetings were held in the two large halls of the Exhibition buildings, and numbered altogether thirteen, commencing on Tuesday, August 31st, and terminating on Tuesday, September 7th. At each meeting the chairman was a representative of a different nation, Mr. Roger T. Smith having the honour of being the British representative and of presiding over the first meeting of Section E, which dealt with the subject of "Railway Electrification." As has already been mentioned, the various reports on this subject were summarised by Dr. E. Huber-Stockar, and we give below a short abstract of his summary, followed by a report of some of the more interesting speeches in the discussion.

THE ELECTRIFICATION OF RAILWAYS.

Electrification is the latest, and in certain respects technically the most difficult, and economically the most doubtful, application of traction on rails. The problem of the electrical operation of railways has been solved technically, and electric traction has caught up with steam traction in most technical points, in many it has even overtaken it. Improvement, simplification and uniformity of details, as well as economies, are to be expected; but no electrotechnical novelties which could change fundamentally the position of electric traction in comparison with steam traction are to be expected. Neither can it be assumed that steam locomotives or thermal locomotives of any other kind could be perfected to such a degree as to make the success of electric traction doubtful.

The number of the electrifications already executed is not a small one. In general, the technical experiences are good, and so far no electrifications have ever been regretted. On the contrary, they are in high favour, not only with the public, but also with the staff; but to many people the economical success, which is not denied, does not seem great enough in proportion to the financial burdens, which are inevitably connected with big electrifications.

This economic uncertainty is delaying many electrifications. Detailed reports are requested by every conscientious administration, which is about to propose an electrification; but investigations with a large display of figures and calculation should not be expected to decide mathematically whether or not electrification is the thing to do. Electrification is connected with expenditure, as is the construction of new lines, the rebuilding of big railway stations, the laying of second tracks, the adoption of more efficient locomotives and the like. Such expenditure can as a rule be remunerative only if these improvements are fully utilised. Such improvements cannot be delayed until it has become impossible to get along without them. Therefore, the reason for taking the risk of such expenditure is based on the expectation that traffic will increase and make it pay. It is safe to say that without such an increase most of the big and expensive improvements would be an economic failure. They are carried out because it seems necessary to do so, even if there is no immediate necessity for them at the time being.

Undeniably, electrification brings about improvements in operation and greater efficiency of a railway. It is a foundation for economy in working and, according to circumstances, enhances passenger traffic more or less. Therefore one might imagine that an electrification which is not evidently out of question involves less risk than other costly improvements and enlargements within the same railway.

In fact, most electrifications on a big scale, which were not dictated by technical necessities, were carried out by State railways, the credit of which is determined by the national or international credit of the respective States. A State may have weighty economical reasons for making electrification possible; for instance, the reduction of the surplus of imports on exports by a reduction of the importation of coal, the utilisation of native water power, the industrial development of the country, the creation of new opportunities for industry and trade. Its interest in the various effects may even be so great as to justify the encouragement and facilitation of the electrification of private railways by financial assistance in some way or other.

In many countries the leading railway companies or the Government have chosen a definite system for electrification, thus eliminating an essential obstacle to developments. There is only one country, Italy, standing in the first rank as to success and extension of its electrified railways, which gives the example of uncertainty as to the system for future electrification.

The United States of America are still undecided on the question of selecting a current system for their group of electric railways. No doubt the lack of uniformity in the railway operation of the country is to be blamed for the opposition of many administrations concerning electrification. None of them cares to run the risk of standing alone in its choice of a system. To-day when the contest for the system has ceased, this drawback does not altogether lose its effect, even though it is generally admitted that successful electrification depends to a lesser extent on the choice of a system than on the quality of its execution.

Many of the larger electric railway enterprises produce most of the energy in power stations operated by themselves. A short reflection leads to the conclusion that the production of energy and its transmission to the main feeding points are economically the best part of the enterprise, if the traffic is fairly heavy and the lines of the railway network are not too far apart from one another. Most power stations owned by railways were not built as a matter of principle, but for purely practical reasons or owing to other compelling circumstances. The same is true with regard to all power stations not operated by railways.

Just as the existence of different current systems causes a delay in the development of electrification projects, so does the existence of different methods of supplying energy exert a similar effect.

Electrifications can be classified according to different points of view; for instance, as follows:—

(A) Electrification of new railways.
(B) Electrification of existing steam railways.

The electrifications of class B, which are of most interest, can be subdivided as follows:—

(*a*) Electrifications made necessary by purely technical considerations.

(*b*) Electrifications made necessary by technical as well as economic reasons.

(*c*) Electrifications which are not compulsory at all, either at present or in the future, but which will be otherwise advantageous. The latter can be further subdivided as follows:—

1. Electrifications on a relatively modest scale, which can be regarded as a trial of electric operation and which may be extended later on.

2. Electrifications of certain big lines or groups of lines, on which steam traction has plainly shown itself to be inadequate and on which electric traction would offer advantages in economy and operation and so raise the net profits.

3. Electrifications of entire railway systems or greater parts of them, particularly their main lines.

As used here the terms railway and railway system are intended to denote systems, parts of systems, or single lines which are under the control of the same administration.

Class A consists of the electrifications of tunnels, as, for instance, the Baltimore, Cascade, Detroit, Hoosac and Simplon tunnels. The technical reason for tunnel electrifications is the smoke nuisance, which is inseparable with steam traction in long tunnels. This smoke is unhealthy and endangers the operation of a tunnel to such a degree as to finally render it impossible in the case of heavy traffic. Little capital is required for such installations, and it may be even considered small when compared to the costs of construction of the tunnels in question. These costs are accepted as a necessity, and the question as to whether steam traction would have been cheaper than electric traction does not arise.

Class B (*b*) includes, for instance, the following electrifications:—

1. Terminal stations in big cities and their approaches: Quai d'Orsay, Paris to Juvisy, Pennsylvania Station, New York to Manhattan Transfer, Grand Central Terminus, New York to Harmon.

2. Metropolitan and District Railway, London.

3. Lines subsidiary to the main line systems in large cities and their suburbs.

4. Railway lines radiating from the main stations of large cities into the suburbs.

5. Main lines across mountain ranges: Giovi, Mont Cenis, Gotthard, Albula, Arlberg. (Loetschberg belongs to class A.)

The characteristic feature of this class is that the electrifications were a necessity to which the administrations had to yield or would shortly have been forced to yield. On other railways where conditions are similar and which have not been electrified up to now the necessity for electrification already exists or will come into being as soon as traffic increases. In the cases of examples 1 and 2, electrification was definitely carried out owing to the necessity of reconstructing the terminal stations of Paris and of New York respectively. In the other examples the administrations foresaw the difficulties which would have resulted from the retention of steam traction, because those difficulties were already making themselves felt.

With the exception of the smoke nuisance there are no other compelling reasons of a technical nature for the electrification of existing railways, at least with existing steam railways, as long as it is possible to attain the same results with steam traction, either with efficient steam locomotives or with corresponding rebuildings or both.

In all the electrifications summarised under example 1 a practical solution other than in the form of electrification is almost inconceivable even to-day. In these examples electrification was an absolute necessity for the creation, maintenance or reconstruction of big railway stations, such necessity requiring the grave consideration of the administrations with regard to the question of traffic efficiency. In such cases electrification was the only salvation; in New York the elimination of the smoke nuisance was even categorically demanded by the authorities.

In example 2 the smoke nuisance would also be serious enough, under present-day conditions, to induce the authorities to order electrification. It is impossible to see how the present traffic could be handled on the existing tracks, and in the tunnels otherwise than by electric traction.

In example 3 and 4 the smoke nuisance also played an important part. But the decisive factor was and is the knowledge that electric operation of interurban and suburban railways with heavy traffic is far better, from a technical and economical point of view, than steam operation, and can be regarded as the only means of keeping up or restoring the capacity to compete with other kinds of transport within the same urban and suburban areas.

The electrifications, summarised in point 5, each contain a long tunnel in which the smoke nuisance had reached the limit of tolerance and the electrification of which would have paid, if executed in accordance with the conditions of class B (*a*). At this time electric traction had been developed so far and was so well known to be better for the operation of long heavy gradients than steam traction that there was no hesitation in electrifying not only these long tunnels, but also their approaches up to such distances as best suited the working conditions of the line, this especially as many of these approach lines contain many tunnels.

It is easier to question the necessity and the economic and financial success of these electrifications than of those contained in the examples 1 to 4. For instance, it may be argued, especially after the event, that more efficient and more economical steam locomotives could have been purchased. Moreover, if the traffic does not develop in the way which had been expected, thif may serve as a means of argument. However, in a general way there is no doubt that it is a good thing to electrify transalpine railway lines carrying heavy traffic, as well as lines containing long and steep gradients and many tunnels, as soon as it is possible to finance them and as soon as electrification becomes necessary on account of being the simplest, most effective and cheapest means of beating competitors and maintaining the capacity of the line.

The electrifications of subdivision B (*c*) 3 are those, of which there will have to be many, if the railways of the whole world are to be electrified. The total of existing electrifications and of those under construction makes up but a small part of the total railway mileage of the world to-day. The electrifications belonging to these subdivisions are of great extent and represent a very keen competition to steam traction. They furnish us with technical and economical experiences, which is of particular value in deciding the possibilities of railway electrification in general.

The rapidity with which electrifications develop is determined by the urgency of the causes which led to their adoption. It will also be determined by the further development of the economic situation of the railway and by the extent to which other fields of activity are attracting investors. Here we are not going to risk a prognostication.

All railway experts have known for a considerable time that electric traction is superior to steam traction when the following factors are present:—

(1) Dense traffic.
(2) Expensive coal.
(3) Cheap electric energy.
(4) High cost of labour.
(5) Steep and numerous gradients.
(6) Low interest on the capital required for electrification.

A knowledge of these points satisfies no administration which is to take the responsibility of an electrification. Points 1 to 4 give the cases in which electric operation will mean an improvement as compared to steam traction after a certain time. But all of them are quantitatively indeterminate. In every case, where an electrification is being studied, they merely answer the questions, whether the traffic is heavy, the gradients numerous and steep, the coal not cheap enough and electric energy not too expensive, the savings in wages large and whether the capital for electrification not too expensive.

On account of the large variety of the different cases these questions cannot be answered in a general way. However, there are no cases which cannot be compared in one way or another with some existing electrification. These latter are so numerous and vary so greatly that correctly selected groups of them will furnish a good foundation for the planning of any new electrification.

The most effective and valuable help in promoting electrification is likely to be the spread of a proper understanding of the results obtained with electric operation both regarding plant and equipment and in relation to the traffic conditions. There exists a very extensive literature on the subject, which, however, is with difficulty made use of owing to the great variety of ways in which the subject is presented and especially the methods of comparing electric with steam traction. Many gaps occur in the various reports and, in short, there is an entire lack of plan which would ensure comprehensive treatment, and without this the mere characteristics of the system and operation are insufficient.

It is suggested that a considerable part of the discussion should be devoted to the consideration of a standard method of describing and analysing electrical traction equipment and its operation. The discussion should not be concerned with the adoption of such a scheme itself, but should be directed to a consideration of the data necessary and how it should be obtained. This will give an opportunity of mentioning the large amount of valuable data contained in the various national reports.

It is not possible to give any details of such a scheme here, but it will be briefly outlined by the general reporter in his address.

The World Power Conference is greatly interested in perfecting the methods of describing electrical installations as regards equipment, output, and costs. The larger the number of reports on the subject, the better will they be able to judge of the future importance of electrification and to assist in its furtherance.

The paper concludes with an appendix giving the data required for the calculation of the annual cost of operation of electric traction in relation to steam traction.

The discussion on the first day was opened by Colonel E. O'Brien, who, in amplification of his paper on "The Economic Aspects of Railway Electrification," emphasised the improved use of terminal stations which electrification brought about. The number of locomotives for a given service was reduced and the occupation of the tracks was lessened. There was no time and space wasted in the turning of locomotives, and the need for the provision of water and coal also vanished. For these reasons electrification would often allow an indefinite postponement of extensions which would otherwise be necessary. He also pressed the importance of standardising locomotives and track equipment in order to reduce capital and maintenance costs. Most electrification schemes had been unduly costly owing to the large amount of experimental work involved.

Monsieur Parodi, referring to the electrification work carried out in France, said that on the Midi Railway there were now 700 kiloms. of electrified track, on which 10,000 train kilometres were run every day. On the lines radiating from Paris, with four tracks for a route length of 80 kiloms., there were run 750 train kilometres per day. These lines were operated at 1500-volt direct current. Monsieur Parodi had just heard that during the preceding two days an electric service had been operating between Paris and Orleans without difficulty. He agreed with Colonel O'Brien on the question of standardisation. On the Paris-Orleans line there were 200 locomotives, and on the Midi Railway eighty locomotives all of the same type, with motors mounted on bogies. That type had been standardised for medium-speed passenger and goods service. There was not enough experience yet available to enable high-speed passenger locomotives for long-distance service and for speeds from 100 kiloms. to 120 kiloms. per hour to be standardised. It was therefore thought best to make trials of various types, and there were consequently five different patterns on the Paris-Orleans line and one on the Midi. Mechanically all of them had proved satisfactory, and there were engineers in the room who had travelled on the footplate at 120 kiloms. per hour with no more discomfort than the passengers in the trains.

Mr. John W. Lieb raised the point of the advisability of the electricity supply for railway purposes being co-ordinated with that of the supply for general

industrial and domestic purposes, if the cheapest generation and distribution was to be obtained. He remarked that while in the United States an effort had been made to standardise on three-phase, 60-cycle current for all purposes, it must be remembered that in the metropolitan districts round New York the usual frequency was 25 cycles. Current was generated at that frequency for low-tension direct-current distribution on Manhattan Island, and most of the railway services took their power from the 25-cycle system. The New York Central Railroad, the first of the electric railways of the city, took 25-cycle current and converted it to direct current for use with a third rail. The New York, New Haven and Hartford system was worked by 25-cycle single-phase current. It was very important to correlate the supply of electricity for all purposes, and it was possible that the hesitation of the United States to proceed with large railway electrification schemes was due to the doubt as to the system of supply which would best suit both the railway and other consumers. The tendency was certainly for the supply of electricity to remain in the hands of power companies and for the railways to buy what they might require. It was significant that at the last meeting of the National Electric Light Association a few months ago a resolution was passed that electric light and power companies should be ready to make long-term contracts for the supply of power to railways, undertaking all generation and transmission and delivering power in any form desired at suitable points on the line.

Professor Enström remarked that whereas Sweden used single-phase current for railways, the energy was taken from the general three-phase system, conversion being effected by motor generators in sub-stations. Thus a conveniently low frequency of 15 or 16⅔ cycles could be used for the railways. Even with this frequency the interference with the telephone and telegraph circuits was bad enough, and what it would be with 50 cycles one could hardly imagine, unless the signalling circuits were completely reconstituted or removed from the proximity of the power circuits.

Mr. Verebely, speaking of the necessity of correlating the system of railway power supply with that of the ordinary supply, referred to a paper he had read at the first World Power Conference, containing a detailed report on a new type of locomotive taking single-phase current from an overhead line and converting it to three-phase current for driving the motors. A 2000-kilowatt locomotive built on this principle to the designs of Mr. Kondoo had been running for three years on the Hungarian State Railways with excellent results.

Mr. Scott-Maxwell considered that if railway electrification was merely an engineering problem there would be more railways electrified than at present. When electrification was first discussed over twenty years ago all the railway companies wanted their own power stations, but the modern tendency is for power to be generated by companies specialising in that work, leaving the railways to their proper duties of transportation. As Colonel O'Brien had pointed out, there would be a great saving in the cost of electrification if we could depart from the steam ideal of very heavy trains and approximate more closely to the electrical ideal of lighter and faster trains. The principal American constructors of electric traction machinery had recently expressed the same opinion to the speaker, but they said that when they approached an American railway with a proposal for electrification they were met with the demand of the traffic manager for electric locomotives to pull trains twice as heavy as any steam locomotive would handle, and at a higher speed. It was further desired that there should be no restriction on the bunching of trains on any section, and all trains must be able to be got away as quickly as possible. Such requirements meant increased cost of permanent way, sub-station and overhead equipment, all because of the old steam traditions of the traffic engineer. In America legislation had recently been brought in by the labour unions making it illegal for a goods train to be run with a crew of less than five men, whatever its size. The tendency, therefore, is to use bigger and bigger trains; 10,000-ton trains were now running, and 20,000-ton trains were being discussed. An increasing number of engineers were, however, coming round to the view that faster and lighter trains would be preferable. If the electrical engineer was not hampered by the psychological factor of the travelling public, he could easily provide trains which could be operated without any train crew at all, the control being effected automatically so that no collision was possible.

The section resumed its sitting at 2 p.m. under the presidency of Professor A. Enström. The first speaker was Dr. Huber-Stockar, the general reporter of the section, who indicated shortly the progress made with the electrification of the Swiss railways. After speeches by Messieurs Eggenberger, Dudler, Habich and Wechmann, Monsieur Jobin referred to the economic perspective of the Swiss railways. He said that whenever one talked of electrification there were visions of wonderful technical and financial success, but one heard very few figures showing how electric working compared with operation by steam locomotives. In the report on the Swiss railways the question of cost had been dealt with, and the results were perhaps rather less rosy than those which many people would like. The speaker proposed to touch on those points on which amelioration was possible. At the present moment there were in Switzerland 1600 kiloms. of line which would be completely electrified by 1928. So far 1000 kiloms. were electrified. The whole of the electrification would cost 680 millions of Swiss francs. Of these 680 millions, about 75 millions represented extra expense incurred by reason of the excessive prices ruling at the termination of the war. Deducting this excessive cost, which would not enter into the estimates of any country at present, he noted that with the present traffic using about 200,000 kilowatt-hours per kilometre electrified, all the capital sunk in electrification in Switzerland will certainly earn 5 per cent. In the sum of 680 millions 190 millions represented electric rolling stock and 120 millions steam rolling stock. Furthermore, the return of 5 per cent. took no account of the fact that with electric traction one could use single-man control. That plan was actually on trial on the Swiss Federal Railways, and if universal would mean a return of nearly 1 per cent. on the capital employed in electrification. In the report there were to be found the cost of all the installations so far made, and in particular the cost of the power stations. It was therefore easy to calculate the cost per installed horsepower and the cost of the transmission lines. Similarly with the cost of the sub-stations. In Switzerland single-phase current was used throughout the system of 1600 kiloms. with twenty-three sub-stations. With continuous current many more sub-stations would be wanted. On the other hand, with another form of current one could take power from the industrial transmission systems. That certainly would be some advantage, but would it be for the railways or the power companies?

Other speakers were Dr. Kruschka and Laszlo de Verebely, who discussed the relative advantages of various systems.

On Friday morning the section held its final sitting under the presidency of Herr Paul Dittes, General Manager of the Electrification of the Austrian Railways.

Mr. Theodore Rich said that the remarks by one of the speakers to the effect that there had been no changes of system on any important railway were not quite correct, although the changes had not always been made for technical purposes. On the Southern Railway in England there had originally been a section built on the Winter-Eichberg single-phase 5000-volt system, running for 15 miles out of London, but with the unification of the railways it was very inconvenient to have that system sandwiched between third-rail direct-current systems, and during the last few weeks it had been decided to remove the single-phase system altogether. In France, on the Midi Railway, single-phase 16-cycle current had been replaced by direct current.

Monsieur Parodi mentioned that on the line from Scheveningen to the Hague in Holland single-phase current had been replaced by continuous current at 1500 volts.

Colonel O'Brien remarked that with regard to electrification the railway administrations would only judge by results, so the best way to make progress was to publish results such as Dr. Huber-Stockar had done. In most cases of steam locomotive operation fuel represented only from 30 to 40 per cent. of the total cost of locomotive operation. There was a tendency on the part of electrical engineers to make their locomotives excessively complicated; a man might have nearly a dozen different voltmeters and ammeters to look at, all of which added to complication and cost. Some years ago for suburban traction the speaker had eliminated all voltmeters and ammeters from the cabs, and the only meter the driver had was one to show if the current was on or off.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

A NEW STEAM CHART.

SIR,—In the notice in your issue of August 27th of the enlarged Mollier diagram, plotted by Professor Callendar and published by this Association, you deal with the fact of the chart being plotted so that the heat drop is read horizontally. In this connection I would say that this form was adopted only after thorough consideration by our Turbine Committee, and the following were the advantages which it was considered to offer:—

(*a*) By measuring the heat drops horizontally a T-square can be used for plotting heat drops instead of a set-square. On a large-scale chart this is a great convenience and also eliminates a likely source of error.

(*b*) With the chart as plotted the points with which one is concerned in the design of the turbines lie in a region which is closer to the observer than if the older method is adopted. Thus, using the chart is a far less trying and painful business with the chart as plotted than it would have been with the older method.

(*c*) With the chart as plotted the man using it will find that the directions of the lines in general follow the direction in which his eye will naturally run, with the result that fewer mistakes are made in transferring a point to the axes giving the properties wanted.

(*d*) Before the method of plotting was adopted by the Committee the chart was thoroughly tried out in a number of turbine design offices by a large number of people experienced in the use of such charts. It was found that after the character of the chart was appreciated the method of plotting resulted in very great conveniences to the users. Several who were prejudiced at first changed their opinion after experience with it.

E. B. WEDMORE, Director and Secretary,
B.E. and A.I. Research Association.

London, September 6th.

RAILWAY STANDARDISATION AND GROUPING.

SIR,—In your article on "The Railway Position" in your current issue there occurs in reference to the results which have followed grouping the phrase "standardisation has made little, if any, more progress than it was making under the old conditions."

This statement must surely have been made under a misapprehension, as it would appear to be at variance with the facts. It is undoubtedly the case that prior to grouping there was some tendency towards the adoption of similar practice, particularly in such matters as wagon design, in which the Railway Clearing House is interested; but acquaintance with the position in 1922 and at the present time makes it impossible not to be aware that such standardisation had proceeded but a small distance prior to grouping compared with the progress since.

In directions such as locomotive and carriage design, permanent way details, &c., standardisation between the independent railways existing in 1922 was non-existent, and every line had, for example, its own patterns of chairs, fish-plates, and fastenings, and there were many different sections of rails. At the present time there is one standard main line track of uniform design for rail section, type of chair, method of fastening, &c. In wagons certain types are now standard throughout the country. But within the individual groups standardisation has proceeded much further. Prior to grouping each principal railway had in current construction a number of types of locomotive, tender and tank for both passenger and goods services, and a variety of designs of coaches, none of which secured interchangeability in detail with those of any other company. At the present moment the total number of types in current construction in any of the big groups does not exceed the pre-grouping currency of one only of the larger constituent companies, and the elimination of variety effected since grouping and arising out of it is therefore very considerable. A notable instance is that of one group who are now building one only design of goods brake van, whereas their constituent companies were found to possess over forty varieties.

It is possible that confusion has arisen owing to the great number of old patterns or types still in evidence; but it is obviously not practicable to withdraw a vast quantity of relatively modern equipment. The progress in standardisation is shown in the fact that current construction represents but a small percentage of its former variety.

As you state in an earlier paragraph, it is highly probable that the standardisation effected does not exceed what the companies had in mind, but that its realisation has been largely facilitated by grouping would appear to be equally unassailable.

Whetstone, September 4th. L. A. F.

[Our correspondent's last paragraph seems to indicate that he agrees with us. "Internal" standardisation has been advancing for years past, and there is little doubt that it would be just where it is now had grouping not been introduced. The adoption of standard rails and so on is a natural result of the work of the B.E.S.A., which was begun long before the Railway Act was thought of.—ED. THE E.]

FAILURE OF A CONCRETE ROAD.

SIR,—Engineers who, like myself, have been advocating concrete roads for the last ten years will thank both Mr. Meek and you for the publicity given in the present issue to the cracking of the concrete road in Manchester.

It does seem a regrettable state of affairs that we have at this date to be educated and convinced as regards concrete roads by something going wrong with an up-to-date road as this appears to be. I have not seen the road in question, but notwithstanding the crack illustrated, the work appears to be a good example of the go-aheadness of Manchester.

I have examined many of the concrete roads built in this country and, in my opinion, any cracking is due to the omission of proper expansion joints, probably in this case also in some degree to the fact that the proportion of cement in the bottom layer varies too much from that in the top. This road, in my opinion, should have had a proper expansion joint longitudinally on the centre and a cross expansion joint at the end of each day's work, and without the tar-spraying and the upper reinforcing no crack trouble would then have arisen.

London, September 4th. W. MUIRHEAD.

THE CANDY MODULE.

SIR,—In the description of the new filtration plant at Walton-on-Thames in your issue of July 30th a module (Fig. 7), which was designed and patented by me and which I described in my paper, "The Commercial Metering of Air, Gas and Steam," before the Institution of Civil Engineers in 1917, and which has been largely used for the control of air and water flows, is referred to as "The Candy Module."

It seems somewhat unfair that my own name or that of my firm, George Kent, Ltd., of London and Luton, who manufacture the module, should not have been referred to in this connection.

Leighton Buzzard, August 17th. JOHN L. HODGSON.

FULL CYCLE.

SIR,—The "Astonished Reader" in your issue of August 13th is evidently confusing the true economic meaning of a "producer" with the popular conception of the word.

Undoubtedly from the modern standpoint, one who causes material to take a definite shape is a producer, whereas your correspondent of July 23rd is obviously an adherent to Adam Smith's opinions, so ably expressed in his "Wealth of Nations."

B. E. MARTIN, B.Sc. (Eng.), London.

Carshalton, August 23rd.

EIGHT specially selected Australian graduates are to be sent abroad for training in research. Two of them will undergo a course at the British Fuel Research Station at Greenwich, two at the Low-Temperature Research Station at Cambridge, one in research in pottery and ceramics, two in forestry research, and one in plant diseases.

Motor-Driven Gap-Bed Lathe.

THE powerful, high-speed, motor-driven gap-bed lathe which we illustrate herewith has recently been made by George Swift and Sons, Ltd., of Halifax, for the Great Indian Peninsula Railway. Although it is a general-purpose lathe, and can be used for sliding, surfacing and screw-cutting work, its main duty in the G.I.P. shops is the boring of the main bearings of motors in position in their casings and the re-turning of commutators. The machine has 17in. centres—although it can be made with 15in. centres—and can swing 27¼in. over the saddle. In the gap it can take work up to 56in. in diameter and 20in. in width. Between the centres it will admit a length of 6ft. 8in.

The form of the bed is shown in the end view—Fig. 4. It is of the three-shear square-edged type, the width across the body being a high percentage of the total width across the shears in order to give great rigidity under heavy cuts. A 10in. gap piece is provided, but narrow pieces can be machined without its being removed. At the headstock end, as shown in Fig. 2, a separate pedestal or stand is bolted to a face at the rear of the bed and carries the driving motor.

The tailstock rides on the two rearmost shears of the bed, and is moved lengthwise by means of an arm extending across the front shear and carrying a pinion which meshes with a continuation of the rack provided on the front of the bed for the saddle. Sideways motion of the tailstock is provided to give adjustment for taper turning.

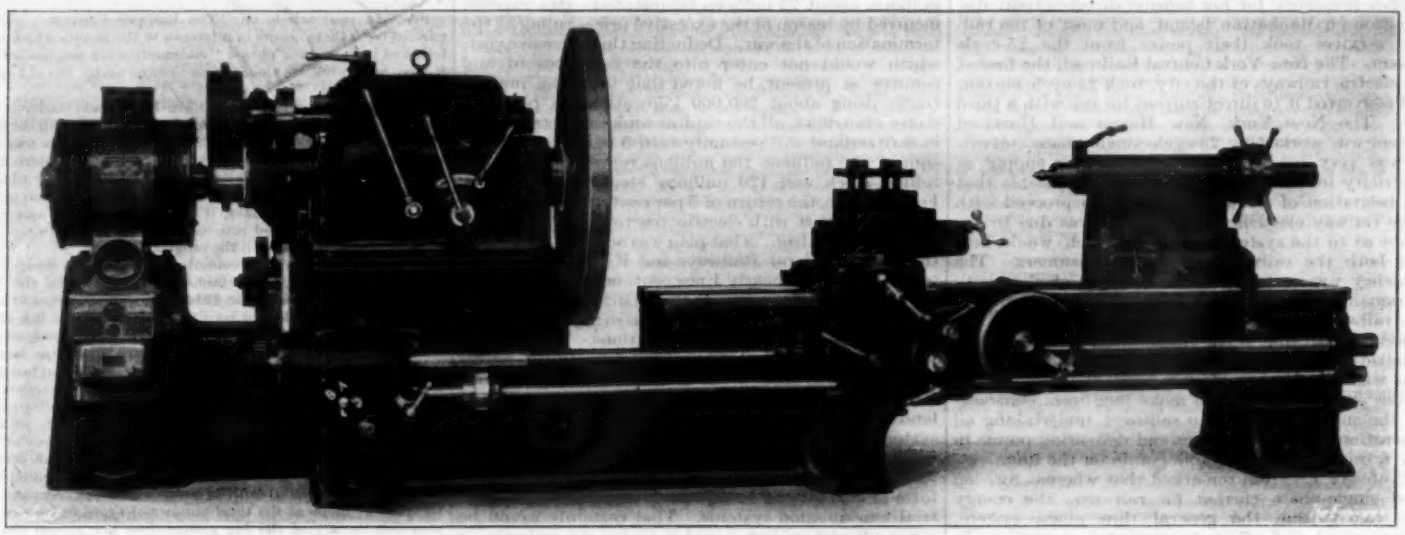


FIG. 1—17-INCH CENTRES MOTOR-DRIVEN GAP-BED LATHE

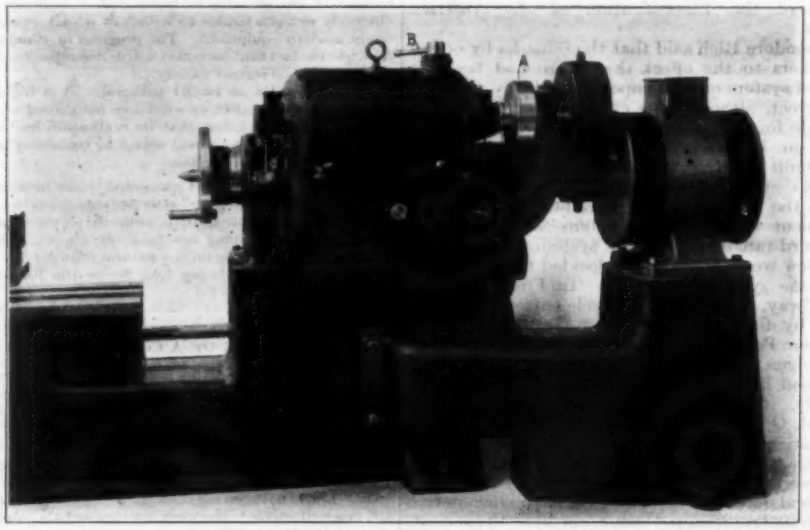


FIG. 2—REAR SIDE OF HEADSTOCK END

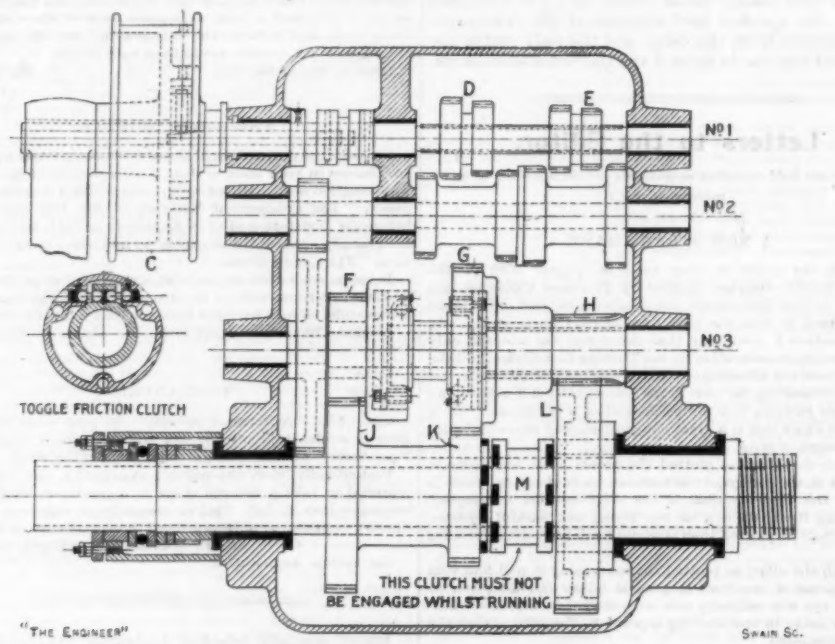


FIG. 3—INTERNAL ARRANGEMENT OF HEADSTOCK

The poppet passes right through the hand wheel, and in all positions has a full-length bearing within the tailstock. Two bolts clamp the tailstock to the bed. In addition, in order to remove all chance of the tailstock slipping backwards when heavy work is being executed, a rack is fitted between the two rearmost shears, and with it there engages a pawl pivoted to the underside of the tailstock. As indicated in the general arrangement drawing reproduced in Fig. 5, this pawl can be lifted clear of the rack when the tailstock has to be moved back.

The lathe is driven by a 12 horse-power motor running at 945 revolutions per minute, and geared to the headstock through a pinion and spur wheel. On the spur wheel shaft there is fitted a friction clutch A—Fig. 2—which is operated by the handle B. In Fig. 3 we show the internal arrangement of the headstock of a machine identical with that illustrated in Fig. 1, except that it is belt driven. The friction clutch in this case is embodied in the driving pulley C, and is operated by the longitudinal movement of a short rod, inclined at its end, which lies within the bore of the driving shaft. Four sliding pinions D E on the first shaft in the headstock transmit four speeds to the second shaft, whence the drive is carried by a pinion and spur wheel to the third shaft. This shaft carries two wheels F G, each of which is recessed to receive a split toggle friction clutch. By means of these clutches either wheel—but not both simultaneously—may be connected to the third shaft or left to run freely thereon. A pinion H is mounted with the wheel G and takes part in its motion. The wheels F G are in constant mesh with the united wheels J K on the spindle, and the pinion H is in constant mesh with the wheel L. If the clutch M on the spindle is thrown to the left, the operation of the friction clutches gives eight speeds to the spindle, four through the pair of wheels F J and four through the pair G K. With the clutch M thrown to the right, an additional eight speeds are obtained, four passing direct from the third shaft through

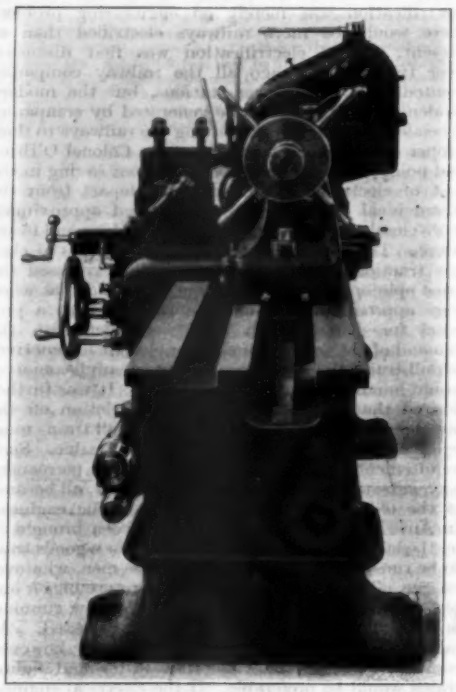


FIG. 4—TAILSTOCK END OF BED

H and L, and four passing through the train F J K G H L. The sixteen speeds obtained range from 6·5 to 136 revolutions per minute, when the speed of the first shaft is 350 revolutions. It may be noted that the gear changes are controlled from three levers on the front of the head, one governing the friction clutches in the wheels F G, one the claw clutch M, and one the sliding of the four wheels D E on the first shaft. It is clear that the two wheels D and the two wheels E cannot be tied together, for simultaneous motion of the two pairs in the same direction would produce a conflicting engagement. Ordinarily, two levers would be fitted to operate the pairs separately, but in Messrs. Swift's machine one lever only is used, namely, the outer of the two shown in Fig. 1, mounted concentrically. This lever is equipped with a four-way gate change, which enables the two pairs of wheels on the first shaft to be moved separately, and which prevents their being moved simultaneously.

The leading screw is driven from the spindle by change wheels, which are independent of the gear train driving the spline shaft. In the transmission from the spindle a reversing motion is fitted. This motion is common to the leading screw and the spline shaft, and enables left-hand or right-hand threads to be cut in the one case, and in the other permits the feed derived from the spline shaft to be applied in either direction.

The feed gear-box is bolted to the front of the bed. Its first shaft is driven by a train of gearing lying to the right of the leading screw change wheels. This train receives its power through the reversing motion already referred to, and is not altered when a change of feed is required. The first shaft of the gear-box carries two sliding gear wheels and the second a three-wheel unit with which three sliding wheels on the spline shaft can be engaged. Six rates of feed are thus obtainable as against the more usual three. With but three rates of feed, the makers contend, there is insufficient variation between the finest and the coarsest feed. The six feeds range from 8 to 57 cuts per inch. Between the saddle apron and the feed box the spline shaft is fitted with a safety slipping device, which causes the spline shaft to slip if excessive force is put on it.

The apron of the saddle is of the double-wall type. A dropping worm is employed to engage the spline shaft, and a push-and-pull knob to select the longitudinal and transverse feeds. A double clamp nut embracing practically the full circumference of the leading screw is used to engage the screw-cutting feed. By means of a safety device the dropping worm cannot be made to engage with the spline shaft, if the clamp nut is engaged with the leading screw, and *vice versâ*. The customary dial is fitted on the apron to enable the leading screw to be engaged at the correct point without the use of a chalk mark. The compound slide rest is mounted to swivel and is graduated in degrees for taper turning. A micrometer adjustment is fitted to the surfacing screw.

GERMAN PLATE-ROLLING TRADE.—Since the failure of the negotiations concerning the formation of a German Thin Plate Association, to which factories rolling middle plate would also have belonged, the middle plate rolling mills alone are now attempting to come to some arrangement regarding prices. The price basis is quoted at 135 marks ex Essen. Endeavours are apparently being made to effect affiliation with the Thick Plate Association, which has a price basis of 148·90 marks ex Essen.

Modern Metallurgy and Ancient Industries.*

By W. ROSENHAIN, D.Sc., F.R.S., Vice-president.

THE antiquity of metallurgy as an art and an industry is very great; on the other hand, the science of metallurgy is modern, and, in regard to some of its aspects, extremely modern. The effects of this new growth of scientific knowledge upon some branches of the ancient metallurgical art are to be considered in this lecture.

We cannot attempt to deal here with the earliest stages of metallurgical art, but it is clear that from the crudest beginnings the practice of metallurgy has gradually developed by a process carried on from generation to generation. An industry developed in this way is full of special and often more or less secret processes. Parts of these are essential to success, while others may be either entirely unnecessary or even detrimental.

It is only at a comparatively late stage in the development of an industry or art that a scientific basis is sought for the operations previously carried out in a rule-of-thumb manner. That attempt, moreover, comes not from within the industry but from without. Scientific investigators have established a number of general principles of chemistry and physics, and an attempt is made to apply these principles to the better understanding of the processes used by the metallurgist. But a highly complex set of conditions has to be met and controlled. The scientific investigator seeking to apply his principles finds at every turn that further fundamental knowledge is required. Almost every application of the known principles of science must be qualified with the reservation that the result aimed at will be obtained only so far as complicating causes will permit.

In spite of these difficulties, metallurgical science has already affected the art and industry of metallurgy in a very profound degree. We are still far removed from the stage at which we have a complete scientific basis for all the operations and processes of metallurgical industry. In recent years, however, the rate at which metallurgical science has advanced has been much accelerated, and it is accordingly producing an increasing effect upon metallurgical practice.

In the story of prehistoric man, the Bronze Age is generally placed before the age of iron. Whether or not we accept this view, there can be no doubt as to the antiquity of copper alloys and even of copper itself. We may rightly, therefore, take the industry of copper and its alloys as typical of an ancient industry. Further, it is probable, if not certain, that some alloys of copper, such as bronze and brass, were produced and used by man long before pure copper was obtainable. Indeed, it is the main point which must be emphasised in the present lecture, that the advance of metallurgical science has led to the production of metals in increasing purity, and that such degrees of purity as are now commercially obtained could never have been reached but for scientific development.

In the case of copper alloys, their early production by man must have been the result of the reduction of mixed ores, probably of the carbonate or oxide type, by means of fire and charcoal. No means of closely controlling the quality of the resulting product were available, and the uniformity of the results obtained must therefore have been dependent upon the uniformity of the ores worked upon. It is in this way, to a large extent, that the high reputation which certain localities enjoyed in antiquity for the production of various metal articles must have arisen. After a time, of course, there would also be a local concentration of knowledge and skill, often passed on from father to son. It is interesting to notice, however, that one of the effects of modern scientific methods is to dispel the idea of inherited skill or knowledge so that, provided that those in control of the industry understand its principles thoroughly, it is by no means difficult to train new workmen to carry out the various operations in new localities. For this reason and for economic causes which outweigh considerations of localised skill in the selection of sites for industry, many of the traditional sites of metallurgical industry are finding themselves in strong competition or even superseded by new centres where the industry is growing rapidly under conditions more favourable than those which existed in the ancient centre. This is an effect of modern scientific development upon ancient industry which may perhaps be deplored in the interest not only of historical continuity, but because it so adversely affects the workers in many formerly important industrial areas.

Returning to the copper industry, we find that it begins with the production of so-called natural alloys, and it has sometimes been suggested, and is still at times maintained, that there is a particular advantage about the production of a natural alloy, and that such alloys are in in many ways superior to those which can be produced by synthesis, that is, by melting together the pure materials.

I do not think that it is going too far to say that such a contention is entirely wrong. We know enough about the nature and constitution of metals and alloys to say that once an alloy has been properly melted and well mixed there can be no difference in the resulting material, whatever the source from which the original metals have been derived. This statement, however, must be taken in a strictly literal and accurate manner. For example, a "natural" alloy consisting mainly of copper and tin might, in practice, prove to be very different in its behaviour and properties from an alloy consisting of pure copper and tin prepared in the same ratio as that existing in the "natural" alloy. The difference, however, would not be due to the fact that one alloy was "natural" and the other synthetic, but to the fact that the second or synthetic alloy had not strictly the same composition. Modern research has shown so clearly the great effects which small impurities or additions can produce in pure metals and alloys, that we cannot afford to neglect these as appreciable constituents of so-called "natural" alloys. If therefore a "natural" alloy is found to be of complex composition, it may not always be sufficient, in reproducing it synthetically, to melt together the two or three main constituents. Careful examination is required in order to ascertain which of the minor constituents may be of importance. On the other hand, it must also be realised that many of these so-called minor constituents or impurities in natural alloys are deleterious, and that their elimination in the synthetic product leads to improved properties.

The progress implied in the production and use of approximately pure metals in place of "natural" alloys has been continued in recent years, under the influence

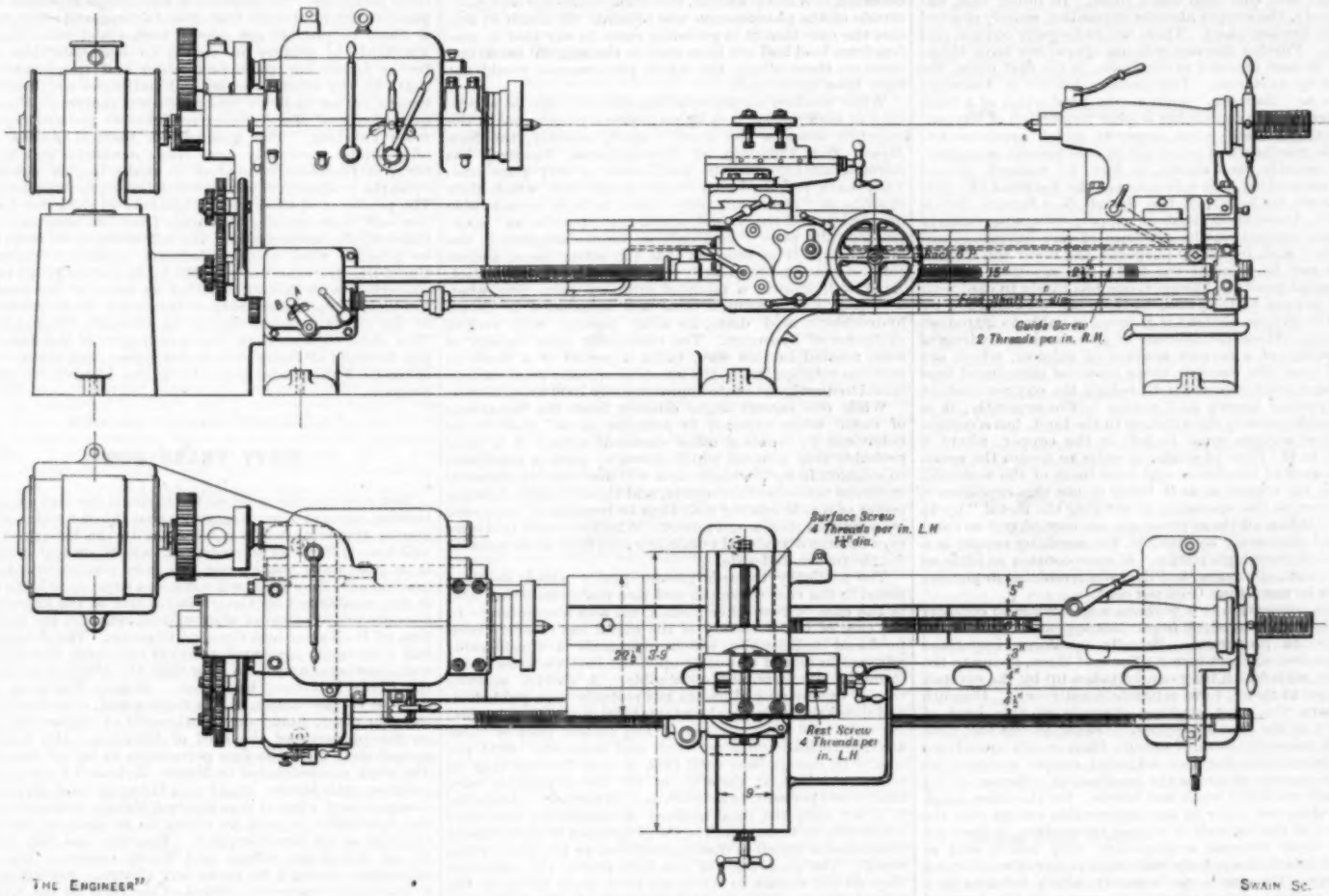


FIG. 5—ELEVATION AND PLAN OF MOTOR-DRIVEN GAP-BED LATHE

* Fifth Autumn Lecture to the Institute of Metals, Liége, September 1st, 1926.—Abridged.

of scientific and metallurgical developments, in the direction of the production and employment of metals of exceedingly high purity. This has, perhaps, been nowhere pushed further than in the case of copper. The older methods of copper refining by means of furnace treatment, leading to the production of those varieties of copper which are known in England as "best selected" and "tough pitch," result in a grade of copper which, in favourable circumstances, is capable of giving excellent mechanical results, combining great toughness and ductility. The advent of the electrical industry, with its enormous demand for copper and its exacting conditions as to electrical conductivity, however, has led to a further development. It was soon discovered that the electrical conductivity of copper is very adversely affected by the presence of minute amounts of particular impurities, such as arsenic and iron, which are never entirely absent in copper which has been produced by furnace refining. Fortunately, the electrical industry, at the same time as producing the demand for high conductivity copper of extreme purity, has also provided the means for its preparation by electrolysis. The electrolytic refining of copper has rapidly grown, until at the present time a large proportion of the world's output of copper is treated in this manner. The direct product of electrolytic refining, known as cathode copper, is a material of exceedingly high purity. Apart from the enclosure of small quantities of the fluid electrolyte, generally sulphate of copper solution, in which the copper is refined, impurities are practically absent.

But the copper cannot be used either for electrical or most other purposes in the form of cathode in which it is obtained from the electroytic refining bath. It has to be re-melted and cast into ingot form. In doing this, unfortunately, the copper absorbs impurities, mainly derived from the furnace gases. These are principally oxygen and sulphur. Further furnace refining operations have therefore to be used in order to eliminate, in the first place, the sulphur by oxidation. This process, known in American practice as "flapping," leads to the production of a bath of molten copper containing a large proportion of oxygen. Now, oxygen itself is an impurity which produces undesirable results when too much of it is present in copper. It has recently been shown, in fact, by research carried out by some of my own colleagues at the National Physical Laboratory on behalf of the British Non-ferrous Metals Research Association, that in copper, otherwise entirely free from impurities, the presence of any oxygen is undesirable; and, for many purposes, the lower the oxygen content can be brought the better the resulting copper. In technical practice, however, one has rarely to deal with copper as pure as this, and, further, the very method by which the oxygen content is reduced is liable to introduce impurities. These may consist of gases such as hydrogen, or, possibly, of a certain amount of sulphur, which are derived from the wood or other material introduced into the molten copper in order to reduce the oxygen content in the process known as "poling." Consequently, it is not possible to carry deoxidation to the limit, but a certain amount of oxygen must be left in the copper, where it remains in the form of oxide, in order to secure the maximum degree of toughness and soundness of the material. Treating the copper so as to bring it into this condition is well known as the operation of bringing the metal "up to pitch." When all these processes are carried out as carefully and accurately as possible, the resulting copper is a material of very high purity. It may contain as little as 0·01 per cent. of oxygen, and the total remaining impurities may not be more than 0·06 per cent.

In this connection it is perhaps worth while to consider the various ways in which impurities appear in a metal and influence its properties. Broadly speaking, impurities may take two distinct forms. Some of them, owing to the difficulty with which they can be taken up by the crystals of the parent metal, form separate constituents. Bismuth is perhaps the most striking example of this kind of impurity in the case of copper. Owing to the fact that bismuth takes the form of minute films or cell walls lying in the boundaries between adjacent copper crystals, its presence rapidly destroys the mechanical cohesion of the metal and renders it weak and brittle. On the other hand, since it does not enter to any appreciable extent into the structure of the crystals of copper themselves, it does not disturb their internal arrangement very much, and so does not interfere seriously with their power of conducting electricity. Oxygen is an impurity which behaves in a similar manner, being present in copper in the form of cuprous oxide (Cu_2O), which forms with copper what is known as a typical eutectic alloy.

Arsenic is typical of the second class of impurity. Here, the atoms of the impurity are more readily adaptable to incorporation in the crystal structure of the copper itself, and, as a result, when the amount of arsenic present is small, it cannot be detected as a separate constituent under the microscope, but exists in the most intimate mixture, or, as it is called, solid solution, in the crystals of copper. The consequence is, in this particular case of arsenic and copper, that the mechanical properties of copper are not adversely affected until the amount of arsenic becomes considerable. On the other hand, the effect on the electrical conductivity is very great, because the presence of the arsenic atoms in the crystals themselves destroys the complete regularity of their structure and interferes with the passage of the electrons which carry the electric current.

It is not possible, within the scope of the present lecture, to go into fuller detail in regard to the influence of impurities in copper and its more important alloys. Enough has been said, however, to indicate that modern requirements demand a degree of purity in copper which could not be obtained by the older metallurgical methods.

For a long time the production of zinc has been carried on in Belgium and elsewhere by the distillation process. It is also well known, however, that the zinc produced in this way, although the best qualities attain a high degree of purity, cannot be freed from appreciable amounts of lead and iron. For a great many purposes, zinc of the purity obtainable from the distillation process has proved perfectly satisfactory, and will no doubt long continue to do so. The process has the advantage, as compared with others, in which still higher purity is attainable, of yielding a much cheaper product, and this cheapness, particularly in the case of zinc, is very important. None the less, here also the modern tendency towards the production of much purer metal is making itself felt. Again, the furnace or distillation methods are being surpassed in regard to the purity of product by an electrolytic process. By this means the content of lead and iron in the resulting zinc can be very much lowered, and for some purposes this is a great advantage. In certain varieties of brass, for example, which are used for special purposes, the elimination of lead is necessary. As an instance may be taken the fact that an ordinary alpha brass containing approximately 30 per cent. of zinc and 70 per cent. of copper is incapable of being rolled or otherwise worked when hot. The hot-brittleness of this otherwise remarkably ductile alloy is accounted for by the presence in it of small quantities of lead. The lead remains in the brass practically in the free state, and consequently melts when a temperature of 328 deg. Cent. is passed. This renders the brass incapable of being hot-worked. If, however, the lead is entirely eliminated, hot-working of the brass is possible, and for certain purposes advantageous.

Freedom from lead in the zinc employed may also be of considerable importance in the case of certain aluminium alloys. An interesting example of the way in which lead affects the behaviour of aluminium-zinc alloys recently came under my notice. The alloy of zinc and aluminium containing about 78 per cent. of zinc has the remarkable property of undergoing spontaneous heating and temporary hardening after it has been quenched from a temperature of 380 deg. Cent. When the alloy is made from high-grade aluminium and pure zinc free from lead, this reaction is rapid and strongly marked. Recently an attempt was made to reproduce this phenomenon in an aluminium-zinc alloy made with a cheaper grade of zinc in which lead was present, and although the reaction still occurred to a feeble extent, the whole character and magnitude of the phenomenon was altered. So much so was this the case that it is probably right to say that if zinc free from lead had not been used in the original investigations on these alloys, the whole phenomenon would not have been discovered.

While modern commercial electrolytic zinc is a product of high purity, it is by no means a pure metal in the scientific sense of the word. Quite recently, the New Jersey Zinc Company of Pennsylvania, America, has devoted attention to the production of very pure zinc. They have prepared two varieties, the first which they describe as "chemically pure" zinc, in fairly considerable quantities, and the second, which they describe as "spectroscopically pure" zinc, only in minute amounts in the laboratory. It is believed that the latter metal cannot contain much more than 0·0001 per cent. of impurities. As is well known, a piece of ordinary pure zinc when wrapped in a platinum wire and suspended in dilute hydrochloric acid dissolves away rapidly, with violent evolution of hydrogen. The chemically pure variety of zinc, treated in this way, takes a period of a week to undergo solution, while the spectroscopically pure variety is said to dissolve at a rate approximately 1000 times slower.

While one cannot argue directly from the behaviour of metal when exposed to solution in an acid to its behaviour in resisting other chemical action, it is very probable that a metal which shows so great a resistance to solution in hydrochloric acid will also exhibit chemical inertness towards other agents, and the corrosion-resisting power of a zinc coating may thus be immensely improved by a marked increase in purity. Whether or not this may ever become a practical possibility on a large scale remains for the future to decide.

The tendency towards greater purity which we have noted in the case of copper and zinc makes itself felt also in the case of two other metals, tin and aluminium. In the case of tin, a variety of the metal has recently been produced industrially which represents a considerable advance in regard to purity upon the best varieties of tin formerly commercially obtainable. A careful analysis carried out by special means has recently been published, and shows that this metal contains total impurities amounting only to 0·0082 per cent. The greater part of these are due to lead ·0025 per cent. and antimony ·0031 per cent. In comparison with this, it may be said that in ordinary standard varieties of tin the impurities vary from 0·094 per cent. to as much as 0·34 per cent. Actually, it is not only the total amount of impurities, but their variability in amount and in the proportion of the different constituents which is disadvantageous to the user of the metal. The properties of this high-purity tin, although they do not depart so strikingly from those of tin of the more usual qualities as do those of the high-purity zinc, yet show a marked difference. Both the lustre and the softness and ductility of the metal are much improved, and there is also a decided increase in the high resistance to chemical action which tin offers. Perhaps the main advantage to be derived from this high-purity material lies in the constancy of results which can be obtained when it is used in the production of alloys.

While tin is perhaps among the commercial metals one of those most easily reduced from its ore, aluminium lies at nearly the opposite extreme. For a long time after its discovery it was regarded as a laboratory curiosity, and its price was an impractically high figure. Modern improvement in the methods of production by fusion electroysis from a molten bath of cryolite, in which alumina is dissolved, resulted in its production at a remarkably cheap rate. The price is still, however, high when compared with that of iron and steel, and in spite of all that has been done to develop alloys of aluminium of very high strength, the price will still have to be reduced to something like one-half or one-third of its present value before the best of the aluminium alloys can compete, strength for strength, with steel.

Within the last few years, Edwards and his collaborators in America have perfected an electrolytic refining process, in which molten aluminium forms both the anode and the cathode of the cell, passing by electrolysis through the fused electrolyte from the impure anodic metal to the highly purified cathode. The result is the production of an aluminium of much higher purity than anything that has hitherto been obtained. The best sample of aluminium which I had been able to obtain prior to the improvement just mentioned, contained about 99·7 per cent. of aluminium, the remainder being mainly iron and silicon. Samples of aluminium refined by the new American process, on the other hand, contain over 99·95 per cent. of aluminium. This high-purity metal again presents marked differences in properties and behaviour from the less pure variety. This is particularly noticeable in regard to the high ductility of the pure metal. While, for the moment, the extremely pure refined aluminium cannot be obtained in large quantities, and does not constitute a commercial rival to the ordinary high-grade aluminium, as manufactured direct from the reduction furnaces, it seems probable that in the future the demand for increasing purity will make itself felt in regard to aluminium as in other metals, so that, although the production of aluminium is not yet an ancient industry, it, too, is being affected by the general tendency imposed upon metallurgical practice by the advancement of metallurgical science.

The question may well be asked, What of the future? It is always difficult and often dangerous to venture upon prediction, and especially so when the advancements of science are concerned. It must, however, be remembered that metallurgical industry and practice has had over a thousand years' start of scientific investigation of metals and alloys, so that it is not surprising to find that our deeper knowledge of metals, acquired by scientific research, is only gradually furnishing explanations of the multifarious phenomena which are met with in metallurgical and engineering practice, and that this new knowledge is only gradually furnishing complete and reliable guidance to our metallurgical manipulation. Whatever direction that guidance may take in the future as the result of further knowledge, it is quite certain that the accurate control of our materials will be carried to a greater extent than it is to-day. Materials which to-day are regarded as laboratory curiosities or as inaccessible rarities are likely to become every day industrial products, and new industrial materials, and particularly new alloys, are likely to be produced. The advance of metallurgical science and, parallel with it, of other branches of science and technology, is likely to provide not merely higher and more correct standards of quality in regard to materials, but also better means for their production and treatment; so that, on the whole, the ancient industries are likely to benefit rather than to lose by future progress. The requirements of the engineer continue to grow more and more exacting. The producer of finished metals and alloys must inevitably meet those demands, and he, in turn, is therefore compelled to make further demands upon the producers of metals which he uses as raw material. The producer of those metals himself, on the other hand, can call upon greater resources from the engineer, the chemist, the geologist and the metallurgist to help him to produce what modern industry requires. Progress, therefore, lies essentially in the co-operation of all those concerned with metals, whether as users of the finished product, as manufacturers of the metal or as producers of the metal from its ore, or as scientific investigators. This close collaboration, the recognition of the unity of aim between all these branches of science and technology, is likely, I think and hope, to be the keynote of future progress.

SIXTY YEARS AGO.

THE trial trip this week on the Clyde of the high-pressure turbine steamer King George V., that latest wonder of the marine engineer, makes a reference to the history of the well-known Skelmorlie measured mile of topical interest. It is just sixty years since the mile was surveyed and marked off. To some it will come as a surprise to learn that it was established on the initiative and at the expense of a single private firm of shipbuilders, namely, the historic firm of R. Napier and Sons, of Glasgow. The Admiralty had a correctly measured nautical mile near Portsmouth and elsewhere, and for a long time the absence of one on the Clyde had been badly felt. Messrs. Napier at last decided to take action in the matter and, searching for a suitable place, found one southwards of Skelmorlie pier, on the property of the Earl of Eglinton. His lordship immediately gave the firm permission to lay off the mile. The work was entrusted to Messrs. Kyle and Frew in conjunction with Messrs. Smith and Wharrie, land surveyors, Glasgow, and when it was finished Messrs. Napier invited the Admiralty to send an officer to re-measure and test the mile at the firm's expense. The mile was duly tested by an Admiralty officer and found correct; but the Admiralty declined to make any charge. According to a "notice to mariners" issued at the time by the Hydrographer to the Navy, the mile, 6080ft., was marked at each end by two beacons, each consisting of a single pole 45ft. high, with two arms 10ft. long. The two poles at the northern end were set 83 yards apart and those at the southern end 100 yards apart, the lines joining the two poles in each beacon, bearing in the same direction, namely, S.E. by E. ½ E. The courses parallel with the measured mile, that is, at right angles to the line of transit of the beacons, were given as N.N.E. ½ E. and S.S.W. ½ W. The shore, it was stated, could be approached within a third of a mile. These particulars are taken from a letter from R. Napier and Sons which we printed in our issue of September 7th, 1866. . . . In the same issue we printed a letter from Mr. C. J. Richardson in which he complained of his treatment by the Government in tests conducted at Woolwich Dockyard on his petroleum-fired steam boiler. His boiler, it seems, evaporated 12¼ lb. of water per pound of oil, but it was only preliminary in its design. Its performance was unfairly compared with that of a boiler fitted with all modern improvements which was used at the dockyard for testing coals. In spite of his treatment, Mr. Richardson maintained that heavy petroleum oil was destined to become the marine steam fuel of the world, and that it would supply the locomotive with a better fuel than any it then had. He appears to have used a steam jet in conjunction with his oil supply, but he maintained that the official report was wrong in describing this jet as "a blast to blow the fire." The water, he argued, served actually as an additional fuel to the oil, his theory being, so far as we can gather from his rather vaguely worded letter, that the dissociated oxygen and hydrogen re-united and generated heat. He definitely wrote of the water as "water fuel," and would seem to have believed that the combustion of the hydrogen generated more heat than the heat required to dissociate it from the oxygen. Mr. Richardson's prediction as to the future of oil as a marine fuel has in part been fulfilled. It may, however, be worth noting here that the King George V. is coal fired.

South African Engineering Notes.

Railway Electrification.

The English Electric Company, Ltd., has secured the contract for the electrical equipment of 83 motor coaches and 133 trailer coaches required for operation on the suburban lines of the South African Railways from Cape Town to Simonstown, the seaside resorts of Kalk Bay and Muizenberg on False Bay, and from Cape Town to Sea Point. The motor coaches will be supplied from an overhead contact line with direct current at 1500 volts normal line pressure. Each motor coach will be equipped with four 185 horse-power motors. The control gear is to be the "English Electric" standard cam shaft type. The work of preparing the suburban lines for the electrical equipment is being proceeded with energetically, and several subways have been put in at various points, because in view of the increased number of trains which will be running, and of the higher average speed, the dangers at present attending the numerous level crossings will be so greatly increased as to constitute a very great danger to pedestrians and vehicular traffic when crossing the railway lines.

Municipal Lighting Activities.

The demand made on the Johannesburg gasworks by consumers during June broke all previous records, and seriously overpassed the capacity of the plant. The consumptions on June 21st and 22nd were 381,000 and 377,000 cubic feet respectively, as against the previous highest record in 1925 of 372,000 cubic feet. The new gasworks will not be ready for two years, and meanwhile the consumers will have to be content with short rations during periods of heavy demand. Practically the whole of the plant originally laid down in 1889 is still in use, and the undertaking is being run at about 150 per cent. beyond its nominal capacity.

The power available from the electricity undertaking of the town of Wellington is insufficient to meet the demand and the town is faced with three alternatives: one to instal another gas engine and generator, which in view of the continued development of the town could only be a temporary expedient; second, to apply for an extension of the power lines of the Electricity Commission, which are to supply Paarl when Salt River Power Station is complete—necessitating a minimum payment for some time in excess of the requirements for supply; third, to dam the Wit River at the top of Bain's Kloof and lay down a hydro-electric station. The cost of the last alternative is estimated at £50,000. This scheme is the one most favoured.

The new electricity station at Bedford—Cape Province—was completed in June, and a commercial supply was begun from July 1st. Somerset West (C.P.) has approved the raising of a loan for electrical extensions and improvements. The Municipal Council of Tulbagh (C.P.) has unanimously decided in favour of an electrical undertaking, and is about to raise a loan for the purpose. The Municipal Council of Walmer—Cape, Eastern, Province—is doing the same. The Caloinia Municipal Council is considering proposals for an electric undertaking, but so far no definite scheme has been adopted.

New consumers of electricity in the City of Cape Town are being connected up at the rate of 2000 per annum, and the consumption is increasing by millions of units annually. A sum of £16,000 has just been expended on new street lamps. Every iron standard up the centre of Adderley-street, the principal shopping street, has been fitted with three alabaster lamps set in flambeau fashion, instead of alternate standards as in the past, and the total candle-power of the street has been increased from 12,000 to 48,000. The electric lights of Plein-street and Long-street are now staggered—that is, placed on alternate sides of the roadway, and instead of 100 candle-power they are 500 candle-power. In the various squares Novalux lights, each standard bearing three lamps of 1000 candle-power each, have been erected. Ruby-coloured globes are installed at all the tramway stopping places. All the tramway routes are at present illuminated by lights placed on every other post, but when the new system is completed—possibly before this note appears in print—every post will have its lamp and every inch of the track will be visible. The City of Cape Town can now claim to be the best lit city in Africa. The old electric light standards were of cast iron, which broke into pieces under impact, and menaced the unwary motorist, but the new standards are of wrought iron held in position by steel tie rods cemented into the road surface. The total number of street lamps is about 5000.

Fourth Gold Record.

The output of the gold mines of the Transvaal for July has just been declared at 860,134 fine ounces, being an increase on June of 7989 oz. This is the fourth record made this year as follows:—March, 834,340 oz.—previous best, 829,437 oz., in July, 1924; May, 849,214 oz.; June, 852,145 oz.; July, 860,134 oz. The value of the July output was £3,653,617, being an increase on the value for June of £33,935.

Oil Ousting S.A. Coal.

The increase in the number of oil-burning vessels is already beginning to affect the output of the South African collieries which supply bunker coal to steamers calling at Union ports. The new Royal Mail motor vessel Carnarvon Castle, of the Union-Castle Steamship Company, recently arrived at Cape Town on her maiden voyage, would, if she burnt coal, have loaded at Durban 4000 tons per voyage, or 20,000 tons a year. This represents so much trade lost to Natal collieries. In addition, a Japanese line has put on three motor vessels instead of coal steamers, and the loss of business here is 12,000 tons. An Australian line has taken five vessels from the South African run, which means the loss of another 30,000 tons. At the same time bunker coal rates over the railway stand at 115 per cent. above pre-war level, and there is no doubt that that is a handicap which is increasing the loss of business.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Awaiting Developments.

INDUSTRIALISTS in the Midlands and Staffordshire are awaiting developments in the coal situation, and as almost everything depends upon the price at which coal can be bought when the pits resume normal operations, both producers and consumers of raw materials are exercising great caution as to future commitments. There is no lack of inquiries on the market as to the possibility of obtaining early supplies of material, but the price factor prevents actual business being placed. The question of whether or not prices will advance directly the iron and steel industry gets to work again is being actively discussed. The general impression seems to be that prices will be higher than those ruling before the strike. A strong body of opinion, however, holds that prices are likely to show very little advance in view of the great reserve of productive capacity, and this view receives some support from the significant fact that the premium demanded for early delivery of some classes of steel has dropped in some cases 10s. per ton. The moderation of price advances has been a special feature of this stoppage. It is quite possible, of course, that if users rush in their orders prices will be inflated, but such developments are likely speedily to find their level. However, for the time being, the market is hanging fire.

Steel Business.

Steel works are very well off for orders, and great activity is assured when a resumption of operations becomes possible. At the moment only a few plants in the Birmingham district are at work. Small steel bars are being rolled in limited quantities, and are obtainable at from £8 10s. upwards. The steady increase in the amount of coal available through the return of miners to work is adding to the activity at local re-rolling mills. Several additional mills have been started in the district, and the better fuel gives improved output in tonnage and quality. The products of these mills are rapidly sold, proving very serviceable to a number of Birmingham industries. Products like joists are not yet being produced in British mills, and heavy tonnages are coming in from the Continent. Blast-furnaces are almost all idle, and cannot resume until the strike ends. At least a month after the strike is the period named as required before furnaces can once more give delivery. Some sales of structural plates have been made at £8 10s. for delivery when the situation becomes normal. There are millowners, however, who decline to bind themselves unless buyers will pay £8 15s. Sections are not commanding more money than they did six weeks ago; indeed, it is reported that some sellers have this week reduced the premiums they have been asking for immediate deliveries, by 10s. per ton. This is regarded as a significant sign as to the future trend of steel values. It is believed, that with the probability of international competition, the British steelmakers will handle prices very carefully, and, in view of the very large capacity, increases are not likely to be substantial, and it is possible that pre-strike prices may return. Large steel undertakings are waiting to be placed, and many shipbuilding yards are in great difficulties for steel supplies. Tube makers, who are employed up to the full extent of their present resources, are getting regular supplies of strip from local mills. Considerable quantities of imported strip are likewise being used. The price named by a home mill was £9 12s. 6d. Continental prices, which have not been subject to the same appreciation as those at home, offer a sharp contrast. Foreign steel bars can still be bought well below the pre-strike price of British steel, and offers of British billets at £6 10s. have brought little response. Belgian billets at £5 15s. delivered have sold rather heavily, and deliveries have improved. Sheet bars are also rather easier at £5 17s. 6d. to £6. British manufacturers fully realise that foreign makers will make a fight to hold what they have secured. Many consumers in this district who much prefer British material if it is available, are withholding further orders in the hope of getting supplies from the home mills before long.

Pig Iron.

Prices of pig iron have not advanced further; indeed, in some instances they have eased slightly. It is now possible to buy No. 3 foundry material for local foundries from a North Durham furnace at £5 6s. 3d. delivered in the Birmingham district. Cleveland No. 3 is on about the same footing. No. 1 is practically unprocurable. On 'Change in Birmingham to-day—Thursday—for East Coast hematite £5 was asked for No. 1, and £4 18s. 9d. for mixed numbers. Foreign pig iron is being used in Midland foundries in larger proportion than formerly. It is obtainable at 12s. to 15s. below the prices required for British pig iron, but the latter is better value for many purposes, and is in regular request. A second consignment of French pig iron has now been distributed in this area. The quality is spoken of as very satisfactory. It will be some time after a settlement of the coal dispute before the furnaces get into full blast again, but it is considered very probable that more furnaces will be blown in than have been in operation for a considerable time. The amount of work available and in prospect is such that additional furnaces will be required to satisfy the demand.

Finished Iron.

The majority of the Staffordshire bar mills remain inactive, and there is little material coming on to the market. Constructional engineers and other users are now being held up for supplies, and the position is daily becoming more serious. Ironmasters are not inclined to make use of the poor fuel available, as experience has proved it unsuitable for the production of best grade iron. A small tonnage of Crown iron is being turned out here and in Lancashire, but the price—£12 to £12 10s. per ton—is above consumers' idea of values. Practically the whole of the common iron being used in South Staffordshire is of Belgian origin, for even previous to the strike local makers could not produce at anything like the figure continental sellers offered supplies at. Most of the Staffordshire mills will be put into full operation as soon as adequate supplies of good fuel are assured, for they have good orders booked for best bars, while the prospects of new orders are considered to be satisfactory.

Galvanised Sheets.

There has been little change in the position of sheets during the week. Mills have a fair weight of orders in hand, but incoming business is slow. For November delivery £16 10s. was quoted for galvanised corrugated sheets of 24-gauge; nearer dates 5s. more. Several local mills are able to give supplies from within a fortnight to a month. The makers have excellent order books, and are assured of full work until the end of the year.

The Miners Return.

The increase in the number of miners returning to work in the Midland coalfields continues, and at the present rate, even without a national settlement, many of the pits will soon be at normal strength. The situation in the Black Country area where 75 per cent. of the miners have resumed work, has eased to such an extent that coal merchants are pressing the local authorities to allow coal to be sold without permits. It is contended by the merchants that ample supplies are being obtained, and there will be no hoarding at the prices charged. In the Cannock Chase coalfield over 8000 miners are at work, while of the 21,000 men and boys normally employed in the coalfields of Warwickshire, 8213 were at work on Monday last. This was the largest number at work on any day since last April. The position in the Notts and Derbyshire district also continues satisfactory.

New Wolverhampton Reservoir.

The Mayor of Wolverhampton—Alderman F. A. Willcock—to-day, Thursday, opened the Corporation's new service reservoir on Bushbury Hill. The reservoir has a capacity of 2,000,000 gallons and forms part of a £40,000 scheme, now complete, for the improvement of the town's water supply. It is of cylindrical form, the internal diameter being 129ft. 4in.; and the maximum depth of water 25ft. It is constructed entirely of reinforced concrete. The walls are divided by buttresses into a series of thirty-two bays, which are arched back against the water pressure, which is transmitted through them to the buttresses. The floor is dish-shaped and is of 6in of concrete reinforced with ½in. steel rods. The walls are 6in. thick, also reinforced with ½in. steel rods. The reservoir is covered by a roof 6½in. thick, with ½in. and ¾in. steel rods, and supported on forty-five columns, reinforced with ¾in. rods. The roof carries a 12in. layer of gravel and soil, on which grass has been sown. The total weight of water supported by the floor, in addition to the weight of the roof and columns, is 9020 tons.

Edge Tool Trade.

Makers of heavy edge tools in the Midlands are experiencing something of a slump. For some time now trade has been very quiet, and there seems little prospect of an early revival. South America has been a poor market all through the summer, while the difficulty of getting steel was a disturbing feature at a time when there was a fair demand from other markets. At the present time fuel and steel could be secured without much difficulty, but the conditions in the East are reported to be rather unsettled, with the result that trading conditions are somewhat chaotic. Normally, the present is a fairly busy season with manufacturers catering for the East, but with merchants nervous, and manufacturers disinclined to work for stock under existing conditions, the position is far from satisfactory. There is so much obscurity about the immediate future that prospects cannot be gauged any distance ahead.

Rolling Stock Works.

Few new orders are being given out just now for railway rolling stock, but the big carriage and wagon works in this district have contracts in hand sufficient to afford full employment if only they could get the raw materials. Before the August holidays production had become unbalanced through the dearth of steel plates and sections. Since then the dislocation has increased. The time is considered unpropitious for the giving out of additional orders of any importance by the home railways, and foreign demands are quieter than they have been for some time. Several small orders have been received on account of India. Some coaches for Palestine are to be made in Birmingham, and there are occasional inquiries from South America.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER.

General Outlook.

THE monthly report to the Government on industrial prospects bears out what has been said in these columns from week to week on the improved outlook for the iron and steel and engineering industries in the Lancashire district. At this stage, however, prospects do not justify the forecasting of a trade "boom" before the end of the year, as one daily paper did in the early part of this week. The outlook is undoubtedly satisfactory; but the fact should not be overlooked that much of the business on the order books of firms to-day represents work that has been dammed up during the past four months. Particularly is this the case in respect of the iron and steel industries. Another point of view, although an unduly pessimistic one, and one to which probably not many people will assent, is that many of the orders that have been publicly announced recently are not of such value as would

have merited attention in more normal and more active times. Many firms on 'Change here have order books that will carry them on for several months at least, but there is no indication of a prospective boom, and few firms are anxious to experience one again. The events of the past few years have taught them that the inevitable price of a boom is a slump. What they would most welcome is a period of steady trade, and this is what they are looking forward to.

Non-ferrous Metals.

In the market for non-ferrous metals during the past week tin has again been the most prominent by reason of the unmistakable signs of continued strength which have been in evidence. The increase in quotations compared with those of a week ago, has only been relatively slight, but it has been registered in spite of a fair amount of unloading by speculative interests at one time. The belief in the statistical strength of this metal is pretty general, and most people are looking for a period of firm values, with the usual spells of reaction. The continental demand for tin has only been quiet, but buying by United States consumers has been fair, and an expansion in that market is anticipated. In the case of copper, values keep steady, although there has been little actual change in price levels compared with those of a week ago. Here, also, the statistical position is sound, warehouse stocks at the end of August, according to official estimates, showing a substantial drop. Shipments of the metal to continental countries have served to maintain this section of the market on a steady basis. Domestic cable makers have also entered the market for fair quantities, whilst the position in the United States from the point of view of consumption remains satisfactory. There have been no special features about the markets for lead and spelter. The demand for these metals has been on rather quiet lines, but in spite of this fact, prices of both show little change on balance.

Iron.

Up to the present, notwithstanding the fact that the pits owned by some of the iron and steel firms in the Midland counties are again producing a fair tonnage of coal, there is no sign of a resumption of operations at the blast-furnaces, and makers are uncertain when they will be in a position to start delivering pig iron again, even when a general settlement is reached. Everything depends, of course, upon how soon the movement of coal is freed from control. Under the most favourable conditions in this respect, it is unlikely that Midland brands will be available in quantity in less than three weeks after the stoppage. In the meantime, Derbyshire iron producers continue to book small orders in this market for forward delivery at prices running from 87s. 6d. to 90s. per ton delivered in this area. With the orders that were on their books when production ceased several months ago, most of them have tonnage enough to deliver that will absorb their output for some time, and one maker hinted this week that further bookings might possibly be suspended before long until the post-stoppage production costs could be definitely ascertained. Offers of Middlesbrough No. 3 iron have been made this week for prompt delivery at from 102s. 6d. to 105s. per ton, Manchester, and of Scotch iron at about 107s. 6d. Supplies of West Coast hematite seem to have come to an end, although small lots of East Coast material have been offered at up to 97s. 6d. per ton delivered. As regards manufactured iron, there are no bar mills working in the Lancashire district, all of them having been closed down since the beginning of the general strike. Stocks have been greatly reduced, of course, although there is still some material to be bought at prices which vary according to holders' ideas of current values. There is no change in the quotations of the Lancashire Bar Iron Association, and £11 10s. per ton delivered is still being asked for forward deliveries of Crown bars, and £10 5s. for second qualities. There are not many users who are prepared to place forward business just now.

Steel.

The steel position is still virtually unchanged. Working on a limited output several rolling mills are producing light plates, sheets, and sectional material, which are being offered and readily bought at up to £1 10s. per ton above the Association figures. Small steel bars are being offered here by re-rollers at about £9 5s. per ton. Both buyers and sellers are avoiding forward commitments as much as possible, but there is undoubtedly a big amount of business waiting to be placed. As it is, some of the biggest firms are assured of an active run for about four months, when the rolling mills get going again. Although there is still a fair business being done in continental materials, a good deal is being held up in view of the delays in deliveries from the Continent, particularly in view of a possible early end to the coal dispute here. Quotations are steady all round, especially so in the case of semi-finished steel, supplies of which are very difficult to obtain. There has been more inquiry about for galvanised sheets during the past week, and a fairly good order has been booked for India. Offers are rather easier on the basis of £16 5s. per ton f.o.b., for the usual Bombay and Calcutta specifications. There is not much call just now for thin gauges, but recent quotations are maintained.

Scrap.

Prices for non-ferrous metal scrap are steady, although there is only a limited demand. Cast aluminium is quoted at £82 per ton, selected gun-metal at £53, clean light copper at £57, braziery copper at £52 to £53, lead at £31 10s., zinc at £25 10s., and brass rod turnings at £39, delivered to users' works.

BARROW-IN-FURNESS.

Waiting.

There are some people who believe that once the coal trouble is definitely settled this district will experience better trade than it has had for some considerable time. This forecast does not apply merely to the production of iron and the manufacture of steel, but extends to shipbuilding and engineering. While these people might be accused of undue optimism, there are certainly signs of better trade in every direction. In the hematite iron trade orders are held which will keep the furnaces going for a considerable time, and as regards steel, there is every reason to expect a long run for the mills with orders which have already been placed, to say nothing of what may follow when the industry is stabilised.

Engineering and Shipbuilding.

In engineering and shipbuilding there is a prospect of better conditions. At present engineering is by no means quiet and contracts are held which will take many months to complete. These orders are mostly for Government work. In the shipbuilding side there is not much activity at present, but the outlook is better, and good news may come to the town any day or may be withheld for a short time. Rumour is busy at present, but for the moment it is sufficient to say that there are more hopeful signs altogether. On Tuesday the Australian submarine Otway was launched from Vickers' yard. This is the second vessel of the submarine type launched recently on Australian account.

Electricity Scheme.

The Electricity Commissioners have turned down Barrow's application for powers to harness the Backbarrow Falls. The Commissioners say they cannot agree with the proposal, and point out that Barrow's trade is poor and the town heavily indebted. The Barrow Council at one time was almost equally divided about this scheme, and many Councillors strongly opposed it. At the meeting this week there was a great change of front, and with only two dissentients, it was decided that the Commissioners should be asked if they were of the opinion that the scheme was sound, both from an engineering and financial point of view. If the answer is in the affirmative, then the Council will do everything possible to obtain powers, for it now feels convinced that the scheme would save the town many pounds. If the scheme is not allowed to go forward, the town will have to take part of its supply from Vickers' power station, and the Commissioners in their letter suggested that the Corporation should do this. It is argued that the cost of producing power at the Backbarrow Falls would mean a saving of two or three thousand pounds when compared with the cost of taking power from Vickers.

SHEFFIELD.

(From our own Correspondent.)

Partial Resumption of Steel-making.

THERE is no general resumption of the great industry of open-hearth steel-making, which has been almost entirely suspended since the end of April, but operations are now being carried on to a limited extent. The exhaustion of stocks of steel has made it necessary to re-start melting, so as to deal with orders that had been accumulating for the past four months. One firm re-lighted a furnace about three weeks ago, and now others have followed suit, with the result that half-a-dozen furnaces are now in commission. They are only small furnaces, and represent a very minor part of Sheffield's huge capacity for turning out commercial steel. Their employment will, however, enable the firms concerned to make progress with contracts for finished products. The production costs will be very high, owing to the price of coal. There are now large supplies of fuel to be obtained in the district, but something like 60s. per ton has to be paid for the inferior continental coal, and 45s. for outcrop varieties, as compared with 19s. or 20s. for South Yorkshire hards before the strike.

The Outlook.

The feeling of optimism with regard to the future of Sheffield trade is still held. Contrary to what might have been expected, the amount of work diverted to the Continent has not been very large, while there are heavy arrears of orders for Sheffield products. It is believed that, when fuel supplies become normal again, both the heavy and light section of the steel and engineering trades will enjoy full employment for several months, if not longer. Conditions in the hand tool trade at present are unsatisfactory, as, while some branches are fairly busy, many others are slack. Although costs of production have increased, owing to the dearness of fuel and other consequences of the strike, manufacturers have not succeeded in obtaining higher selling prices—in fact, competition is so keen that there have been cases of Colonial orders being taken at figures below those which ruled before the strike. There is plenty of overseas business to be placed, and the prospects of the industry are regarded as good, at any rate from the employment point of view, although profits are likely to be very small.

Colliery Matters.

The natural wealth of this district is very great, and that part of it which consists of coal is being exploited on a large scale, in spite of, or rather in consequence of, the strike. I refer, of course, to the outcrop workings, which have been developed on a surprising scale since ordinary coal mining was stopped. The latest news of enterprise of this kind comes from the beautiful district of Midhope, among the hills near Penistone, which has hitherto been chiefly associated with reservoirs and grouse moors. Here, flourishing operations are being carried on in Spring Wood, where about 200 men are at work, and are producing fuel at the rate of something like 2000 tons a week. The coal is largely used for manufacturing purposes, the bulk of it going to the Manchester district, and it is stated that fancy prices are being paid for it. The workers are doing well. Earnings of £10 and £15 per week are declared to be quite common, and in some cases as much as £25 a week has been drawn. A man who has only £7 to receive at the week-end is considered to have done badly. From some of the large collieries in South Yorkshire comes news of a very different character. As already reported, there has been much trouble from overheating at the pits in the Doncaster district, and difficulty has been experienced in getting men to attend to the safety work. At Bullcroft matters have reached such a pitch, owing to the refusal of the local branch of the Yorkshire Miners' Association to allow extra safety men to descend, that the management has decided to seal off the East Dip district. It has found it impossible to cope with the conditions underground without more assistance. The portion being sealed off will probably never be opened again. It contains twenty-seven stalls, the closing of which will displace over 450 men and boys, and will result in a loss of output of 2000 tons weekly. It has been necessary to abandon a quantity of machinery in the district. Work has been resumed at a small colliery known as the Woodthorpe Pit, Intake, Sheffield. The pit is used chiefly for ventilating the Flockton shaft at Handsworth, and the resumption is more in the nature of a safety measure than a step towards coal-getting. The pit is a very old one, and when fully at work does not produce more than 40 tons a day.

Shipbuilding Orders.

Sheffield is interested in the news of two orders that have been received by the Dublin Dockyard Company —Vickers-Ireland, Ltd. One order has been placed by the New Zealand Government, and is for a motor vessel for the Pacific Islands Administration. She will be 210ft. in length, and the main propelling machinery will consist of twin Vickers-Petters hot-bulb "C" type heavy oil engines, each developing 600 brake horse-power. In addition to the Administrator's accommodation, the ship will be fitted to carry about twenty-six passengers. The holds will be refrigerated. The second order is from the Commissioners of Irish Lights, and is for a twin-screw vessel, 190ft. long. She will be fitted out in an elaborate manner as a lightship tender. The machinery will consist of two sets of triple-expansion engines, with two single-ended oil-fired Scotch boilers.

A New Stainless Plating Process.

A new Sheffield company called Stainless Plating, Ltd., has been registered as a private company, with a capital of £10,000 in £1 shares. The names of the first directors are not stated, but I understand that among them are three well-known steel manufacturers, a colliery proprietor, and other prominent Sheffield business men. The object of the company is to carry on a new process of plating, which has already been in operation for about three months, and which, it is stated, has proved commercially successful. The process is applied principally to the fittings of motor cars, tramcars, railway coaches, and similar vehicles. It is well known that ordinary silver-plated fittings become tarnished on exposure to the weather, and that brass fittings are also seriously affected by varying atmospheric conditions. It is claimed that the stainless plating used by the new company will not be affected by any kind of weather. Examples of the work will be available for inspection at the forthcoming Motor Show in London, where many of the car parts will be plated in accordance with the new process.

Bradford Power and Water Schemes.

Bradford Corporation is to apply to the Electricity Commissioners for sanction to borrow £77,800 for new plant at the Valley-road Power Station, and also to the Ministry of Health for permission to borrow £5350 for the installation of pressure filters at Gilstead for dealing with the supply of water to Bingley, Cross Flatts, and Eldwick.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade Captured by Foreigners.

THE enormous extent of the trade captured by foreign countries as the result of the coal stoppage is reflected in the imports of iron, steel and coal to the river Tees. Statistics presented at a meeting of the Tees Conservancy Commission on Monday last showed that during the months of June, July and August and up to September 6th, the imports of coal and coke to the Tees from coastwise and foreign ports, including Belgium, Holland, Germany, Danzig, South Africa and the United States of America, amounted to 192,689 tons, of which 176,988 tons were coal and 15,701 tons coke. The fuel went to various works in the district, and to the Corporations of Middlesbrough and Stockton. Germany has benefited more than any other country, 80,770 tons of coal and 8382 tons of coke being received from that source, whilst 45,181 tons of coal came from the United States, 36,848 tons of coal and 5757 tons of coke from Holland, and 10,760 tons of coal and 1562 tons of coke from Belgium. But for the coal stoppage, all this trade, involving as it does over half a million sterling, would have gone to Northumberland and Durham. Imports of iron and steel are also on an enormous scale. During August 23,987 tons were imported to the Tees, as compared with 16,472 tons in July and 11,394 tons in June. The imports of sheet bars, billets, blooms, &c., increased from 11,042 tons in July to 13,370 tons in August, pig iron from 1404 tons to 5916 tons, and angles, bars, plates, sheets, joists, &c., from 4026 tons to 4701 tons. Imports for the ten months ending August reached 174,258 tons, as compared with 151,839 tons for the same months a year ago, and 53,399 tons for the corresponding pre-war period of 1913–14. Unloadings of pig iron for the past ten months totalled 45,990 tons, as against 15,198 tons a year ago, and 312 tons in the pre-war period; arrivals of crude sheet bars, billets, slabs, &c., to the end of last month reached 108,504 tons, as against 115,225 tons a year ago and 33,646 tons in 1913–14; and imports of plates, bars, angles, rails, sheets and joists for the past ten months amounted to 19,764 tons, as against 21,416 tons a year ago, and 19,441 tons in the pre-war period.

Iron and Steel Exports.

The extent to which Cleveland's iron and steel export trade has been hit by the coal dispute is emphasised by the August official returns of shipments from the Tees.

The total loadings of iron and steel last month are given as only 22,043 tons, as compared with 79,879 tons for August, 1925. Last month's clearances were composed of 5331 tons of pig iron, 1810 tons of manufactured iron, and 14,902 tons of steel. Of the pig iron shipped, 4243 tons went abroad and 1088 tons went coastwise; of the manufactured iron dispatched, 1073 tons went overseas and 737 tons coastwise; and of the steel loaded, 12,702 tons went to foreign ports and 2200 tons coastwise.

Cleveland Iron Trade.

A more hopeful feeling in the Cleveland pig iron trade is indicated by the fact that inquiries are circulating for iron for delivery after the coal dispute is settled. There has been another advance this week of 6d. per ton in prices. These recent advances seem trifling, but the fact is that makers, who are struggling to continue production, are having a desperate fight to make ends meet, and as foreign fuel continues to advance in price, makers have no alternative but to pass on additional expenses to the consumer. That they are able to do so is, of course, only due to the fact that very little iron is now being produced. East Coast hematite is limited to the output of one blast-furnace, and only two are on ordinary Cleveland foundry grades, one other producing a special grade of low phosphorus iron. Thus, with such limited quantities of iron available, the ironmakers are able to get their price, but, of course, such values are purely fictitious, and there is a good deal of speculation as to the ultimate level of prices when normal working is resumed. There will certainly be a fall, but there is such a demand banking up that this fall may not at first be very rapid. Makers, however, do not seem disposed to commit themselves to post-strike business, and consequently there is very little opportunity for traders to operate. Imports of foreign material are heavy, but a difficulty in regard to new business is that deliveries are uncertain. No 1 Cleveland foundry iron is now 93s. 6d.; No. 3 G.M.B. Cleveland pig iron, 91s.; No. 4 foundry, 90s.; and No. 4 forge, 89s. 6d. For export 6d. per ton is added to these prices.

Hematite Pig Iron.

There are still some unsold stocks of hematite pig iron, but these are being rapidly reduced, and with the statistical position becoming stronger, values are inclined to stiffen. Quotations, however, keep on a comparatively low level, as compared with Cleveland iron prices, consumers claiming that they can still satisfy their requirements at 83s. per ton for mixed numbers and 83s. 6d. for No. 1 quality.

Ironmaking Materials.

Stagnation continues to characterise the foreign ore trade, and market rates remain nominal at 21s. 6d. per ton c.i.f. Tees for best Rubio ore. Consumers of coke meet with little success in their endeavours to obtain price concessions for that commodity.

Manufactured Iron and Steel.

Works which are still operating are becoming increasingly dependent upon foreign sources of supply for manufactured iron and steel. Quite a number of firms in this district are now buying abroad, as it is impossible for home producers to meet their requirements. This foreign steel is very dear, and deliveries are often delayed, but consumers have no alternative than to take their chance. There is no doubt, however, that big business will be done by British steel makers as soon as their works can restart, and there promises to be a keen struggle for priority in delivery. Prices are quite nominal, and premiums up to 20s. per ton are being paid in the fixed official manner. Galvanised corrugated sheets are firm at £17 and black sheets, £11 5s. per ton.

The Coal Trade.

There is no special movement in the Northern coal trade, but all parties are looking hopefully forward to the commencement of negotiations for a settlement, and while the divergence between the owners and miners is considerable, it is hoped that the Government will be able to bridge the gulf and bring the dispute down to a moderate difference of view, and ultimately a settlement. Merchants, however, do not think there will be any actual settlement for a fortnight to three weeks ahead; but even this period gives the hope that the last quarter of the year may show a substantial business available. Another colliery has been restarted in Northumberland, but the output for the current week is not expected to be of considerable dimensions. Colliery quotations direct are still in abeyance, pending a more definite outlook as to when the pits are likely to resume. Contractors, however, are actively engaged seeking for trade and are offering all descriptions of fuel to customers abroad. Prices are high, and it is not known what the foreign consumer may think of them. For supplies of best steams after the pits have resumed, speculators are said to be asking 20s. and 18s. to 19s. for delivery in the last quarter of the year. Best smalls appear to be starting off at about 11s. 6d., with other grades of smalls in proportion. Holders of best gas fuel are asking up to 20s., but the ideas of collieries are above that figure.

SCOTLAND.

(From our own Correspondent.)

The General Position.

THE situation in Scotland is practically unchanged so far as actual business is concerned. Feeling with regard to an early resumption of work is more hopeful, but the outlook for the winter months holds anything but fair prospects in the opinions of many, as so much time must necessarily be occupied with getting into working order again. Little has been heard of curtailments or cancellations of contracts, but there can be little doubt that a considerable amount of business has inevitably been diverted elsewhere, while the prospective buyers may probably also have been compelled to revise their programmes. The nature of the settlement of the coal strike will, of course, play a great part, but unless consumers are assured of at least moderately cheap fuel the industrial position cannot improve to any extent in the face of continued stern competition from abroad.

Steel and Iron.

The restriction of business in the steel and iron trades is still pronounced. Few works are in operation, and outputs are necessarily limited, while a high level of prices is maintained. No heavy steel is being produced, and consumers, therefore, can only secure a small proportion of their requirements locally. Steel sheet makers report continued demands for black and galvanised varieties, and extended deliveries are now the rule, while a firm level of prices is maintained. Bar iron and re-rolled steel are in fair demand at steady prices, but the output is wholly inadequate; consumers have been augmenting their supplies by imported material, but deliveries from foreign manufacturers have become unsatisfactory of late, and this business has declined somewhat.

Pig Iron.

In view of the shortage of supplies business in pig iron is almost completely at a standstill. Production being discontinued meantime, stocks, especially of foundry, have dwindled. Some brands of foundry are completely exhausted, and business in the remainder is purely a matter of negotiation between buyers and sellers. Approximate prices show a very firm basis.

Coal.

There has been very little improvement in the position so far as a return to work on the part of the miners is concerned, and consequently the amount of home fuel available for disposal is extremely small. Coke is now unobtainable unless for essential food services. Foreign coal is fairly plentiful, the market for which has been steady despite a temporary tendency to dullness. Good deliveries are reported, but prompt cargoes are now more difficult to arrange. Approximate prices are as follows:—Silesian screened, 50s.; Westphalian unscreened, 47s. 6d.; American unscreened, 47s. 6d., all per ton f.o.t. Glasgow. Scottish patent fuel is quoted about 45s. per ton f.o.b. Glasgow, Bo'ness, and Grangemouth, and 46s. per ton f.o.b. Leith.

Conversion to Oil.

The prolongation of the coal strike has caused the serious consideration of the question of oil *versus* coal by many large concerns, and in this connection it has been announced that the North British Rubber Company, Ltd., Castle Mills, Edinburgh, has converted two-thirds of its plant, which is now adaptable either to oil or coal. Only the probable early resumption in the mining industry has prevented an entire conversion. At the Edinburgh works between 500 tons and 700 tons of coal were consumed per week in the three boiler-houses, two of which have been converted. These mills, employing 5000 people, have during the strike been compelled to work short time, although orders on hand demanded full-time employment.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

ANOTHER week has gone, and when the position is weighed up it cannot be said that any real advance has been made towards a settlement of the coal dispute. When the miners' delegate conference on Thursday of last week passed a resolution authorising the Executive Committee to take the necessary steps to submit proposals for the setting up of a national agreement for the industry, the members knew full well that little or no progress could be made along that line in view of the insistence of the coal owners upon district settlements. In reality, the resolution of the miners was simply a move in the game to place the coal owners in public disfavour. In view of the great diversity of conditions prevailing in the industry, the trading differences and the increased number of disputes which have occurred since a national agreement replaced the district agreements, it is not surprising that the coal owners adhere to their claim for local settlements. There are one or two principles which can be made to apply nationally, such as the payment of a minimum wage and the fixing of the distribution of the net proceeds of the industry; but when it comes to a question of working hours it can scarcely be denied that the utmost elasticity is desired, not only as between districts, but also as between individual collieries. Hopes were certainly entertained a week ago that an early settlement would have been achieved, and it was thought in many quarters that the strike was on the point of collapse; but the position which has now arisen has, in the view of many, set back the clock, and whereas there was a prospect of the strike being over towards the end of this month, fears are now held that the stoppage may go on, certainly in South Wales, into early October, unless there are developments not at present anticipated.

Importation of Coals.

During Friday of last week and the early days of this week, tonnage has been chartered to lift fully a quarter of a million tons of American coals for discharge in the United Kingdom. Rates of freight for fairly prompt steamers sharply advanced from 17s. 6d. to 18s. to as much as 20s., many importers with commitments evidently being anxious to nominate tonnage in case there might be an early settlement of the coal trouble resulting in complications with their receivers. Some of the tonnage which has been chartered runs into October loading, and it is reported that at least 100,000 tons have been taken up on Government account. The fact that tonnage running into October is being chartered conveys the impression to many people and to numerous consumers abroad that the view prevails in quarters most likely to know that the stoppage in this country is not likely to terminate for another month or so; but it should be pointed out that even after the stoppage in this country comes to an end, it will be quite a fortnight before production reaches substantial proportions, and in the meantime coals will be required, whatever their cost. In the early part of this week there were sixteen steamers in the various South Wales ports discharging cargoes of American and continental coals. There has been somewhat of a lull in the buying of fresh supplies, but the improbability of a quick settlement of the dispute is now resulting in importers making arrangements for further cargoes. Prices of continental coals, especially, are higher, and in the past week or so have advanced several shillings per ton, owing to the fact that the producers are so fully booked up for early shipment. In view of the fact so many miners are working in the Midlands, efforts have been made to get some of the coal produced by them for use in South Wales, but these endeavours have failed, as the authorities decline to permit the coal to be sent from the Midland area.

Miners at Work.

It is impossible to give actual figures as to the number of miners who are at work in South Wales, but an official report states that the number is increasing. It is rumoured that altogether it is round about 1000; but in view of the steps which may be taken by extremists to compel these men to withdraw their labour if information is divulged showing where the men are engaged, it is deemed advisable not to disclose particulars. In the Forest of Dean area it is reported that altogether about 1500 men are now at work. There was a breakaway on Monday on the part of a fair number of men who resumed work at the Cannop Colliery, one of the most important collieries in the Forest. Including the safety men, it is stated that the number of miners who restarted is about 250, but since then others have signed on.

Steel Works Contract.

Reference was made recently to the contract which had been secured by Braithwaite and Co., constructional engineers of the Neptune Works, Newport, for the supply of steel water pipes for the Government of one of the South American States. Between 21,000 and 22,000 tons of pipes are required, and it is now officially announced that these will be made at the Cardiff-Dowlais works of Guest, Keen and Nettlefolds. The pipes have to be delivered in six months. It is understood that the Dowlais Works at Cardiff are full up with orders well into next year, and that like similar undertakings the management has taken the opportunity afforded by the stoppage to effect repairs and renewals to the plant which in ordinary circumstances could not have been effected in the space of a year or two. The works will be restarted in a week or so, by which time adequate supplies of imported coal will be available.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MAJOR SIR ASTON COOPER-KEY, who has recently retired from the position of H.M. Chief Inspector of Explosives, has been elected to the board of Allen-Liversidge, Ltd.

WE are requested to say that Millemon (Factors), Ltd., Glenogle Works, Edinburgh, have been appointed by the Westinghouse Brake and Saxby Signal Company, Ltd., as sales service and fitting agents for that part of Scotland including Fife, Kinross, Clackmannan, Linlithgow, Berwick, Roxburgh, Selkirk, Peebles and Stirling, east of and including Falkirk.

WE are informed that Mr. Joshua Fielden Ramsbotham, M. Inst. C.E., M. Am. Soc. C.E., who recently retired from the position of Director of Lighthouses to the Commonwealth of Australia, has now joined Messrs. Wilton and Bell in partnership. The title of the firm will in future be Wilton, Bell and Ramsbotham, with offices at 57 and 59, Victoria-street, Westminster, S.W. 1, and at 18 and 19, Westminster Chambers, 1, Crosshall-street, Liverpool.

BRAZING SOLDER.—The British Engineering Standards Association has now issued a Specification (No. 263–1926) covering two grades of brazing solder. The copper contents for the two grades range from 53 to 55 per cent. and from 49 to 51 per cent. respectively, maximum limits being specified for the tin, antimony, arsenic, bismuth, iron and lead permitted in the alloy. A table is included as an appendix to the specification giving a range of grain sizes of granular solder to which it is recommended that the material be ordered. Copies of this publication may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

FRACTIONAL HORSE-POWER ELECTRIC MOTORS.—The British Engineering Standards Association has just issued a further section of the revision of publication No. 72, 1917, "Standardisation Rules for Electrical Machinery." The revision is taking the form of the issue of eight separate specifications, covering fractional horse-power motors, industrial machines, turbo-alternators, large machines other than turbo-alternators—two specifications—transformers, rotary converters, and traction motors. The new publication is B.E.S.A. Publication No. 170, 1926, and covers fractional horse-power motors, including fan motors, of less than 1 horse-power per 1000 revolutions per minute. The outstanding sections still to be published are those for transformers and rotary converters. Copies of this new publication may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

CLEANSING OIL COOLERS.—The question of how to maintain bearing temperature on steam turbines within the correct limits is continually arising, and in nine cases out of ten, where difficulty is encountered, we find that the trouble lies in the oil cooler. Whilst provision is made for easily removing scale from the water side of such apparatus, it is often more difficult to cleanse the oil chamber, and it not infrequently happens that owing either to the effect of excessive aeration of the oil, high temperatures over prolonged periods, or the use of inferior oil, a considerable thickness of slimy deposit forms, and this has an insulating effect, which renders it practically impossible to keep the oil temperature down. As a result of experiment, Alexander Duckham and Co., Ltd., have devised a cleansing process which can be used without dismantling the unit, and they inform us that they will be glad to apply this treatment to any cooler which is not functioning correctly, either free of charge or on nominal terms.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 2 6	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 3 0	4 3 0
No. 1	4 3 6	4 3 6
Cleveland—		
No. 1	4 14 6	4 15 0
Silicious Iron	4 14 6	4 15 0
No. 3 G.M.B.	4 12 0	4 12 6
No. 4 Foundry	4 11 0	4 11 6
No. 4 Forge	4 10 6	4 11 0
Mottled	4 10 0	4 10 6
White	4 10 0	4 10 6
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0 to 3 10 0	
,, Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	(*None offered.*)	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	(*None offered.*)	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 6 (*a*) / 4 12 0 (*b*) / 4 16 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 10 0 to £12	11 0 0
Best	—	—
N.E. COAST—		
Common Bars	11 5 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—	(*Prices nominal.*)	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	11 5 0 to 12 5 0	
Sheets (Gal. Cor. 24 B.G.)	—	£17 5 0 to £18 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 0 0	—
Angles	7 10 0	—
Boiler Plates	11 10 0	—
Joists	7 10 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 5 0	—
,, (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 2 6	—
,, (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 10 0	
Billets and Sheet Bars	6 2 6 to 6 7 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	7 7 6 to 8 17 6	
Joists	7 7 6 to 8 17 6	
Tees	8 7 6 to 9 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/6 to 23/6
Block Tin (cash)	300 5 0
,, (three months)	296 0 0
Copper (cash)	59 2 6
,, (three months)	59 15 0
Spanish Lead (cash)	32 8 9
,, (three months)	32 1 3
Spelter (cash)	34 2 6
,, (three months)	34 8 9
MANCHESTER—	
Copper, Best Selected Ingots	66 12 6
,, Electrolytic	67 15 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	33 17 6
,, Foreign	32 12 6
Spelter	34 12 6

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£38 10 0	12/6
,, ,, 1 p.c. ,,	£44 10 0	15/-
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£10 7 6 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	15/- per lb.	
,, Molybdenum	5/3 per lb.	
,, Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

LANARKSHIRE— (*Prices nominal.*)	Export.
(f.o.b. Glasgow)—Steam	15/9
,, ,, Ell	16/6
,, ,, Splint	16/6 to 17/-
,, ,, Trebles	15/9
,, ,, Doubles	14/- to 14/6
,, ,, Singles	13/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
,, ,, Jewel	17/- to 17/6
,, ,, Trebles	17/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
LOTHIANS	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

	Export.
(8) N.W. COAST—	
Steams	*No quotation.*
Household	,, ,,
Coke	,, ,,
NORTHUMBERLAND—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
DURHAM—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-

SHEFFIELD (*Nominal: none on offer.*)	Inland.
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
,, ,, House	24/- to 25/- —
,, ,, Large Nuts	17/- to 20/- —
,, ,, Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire Hards	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty Slacks	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 16/- to 17/-

(9) SOUTH WALES.

CARDIFF— (*All prices nominal.*)	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary ,, ,,	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary ,,	16/- to 17/-
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	18/- to 18/6
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	26/6 to 27/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Advancing Wages.

ANY hope of a commercial and industrial recovery in France depends upon the success or otherwise of the Government's efforts to stabilise currency by an adjustment of the national finances. Confidence in the ability of the Government to effect this change is fairly general, although it is attenuated by the disquieting advance in prices of all kinds resulting from the policy of restrictions, heavy indirect taxation and higher charges. There is nothing yet to show that these measures will alone stabilise the franc, but it is certain that they have, for the time being, rendered the situation more difficult on account of the inflation of prices. The franc has undergone some improvement, but its purchasing power has diminished because everything that goes to make up production costs has increased. If the consumer pays fewer francs for the raw material he purchases abroad he has to pay more in railway rates and has to provide more for overhead charges to make up for taxation. Those costs are steadily increasing, more especially the living costs, which are the most serious element in the situation. It is feared that this fact will cause trouble with workers over the question of wages, for while the temporary prosperity of the coal industry has enabled coalowners to accede to the men's demands, it is certain that in most other industries it will be impossible to increase wages to any appreciable extent without threatening a complete dislocation of business. At present business activity is kept in abeyance solely by the financial uncertainty, which has the immediate effect of suppressing credits, and it may be taken for granted that if selling prices advance with an improvement in the franc, there will be no encouragement to consumers to purchase more than what is absolutely necessary. An agitation for higher wages to make up for the increased living costs is extending, and it will be resisted by employers, who find that costs have already reached a limit at which it becomes extremely difficult to do business.

Tunnelling the Vosges.

As a means of facilitating communication with Alsace, it was decided to drive four new tunnels through the Vosges in order to connect Saint-Dié with Saales, Saint-Maurice with Wesserling, Saint-Dié with Sainte-Marie-aux-Mines and Cornimont with La Bresse and Metzeral. So long as there appeared some hope of this work being put through with the aid of German reparations, there was no question as to the utility of all four tunnels, as well as of the numerous other public works which were to be carried out under the same conditions, but in view of the difficulty of providing the necessary funds the Conseil Général des Ponts et Chaussées has now reported that it is quite unnecessary to construct the tunnel between Saint-Dié and Sainte-Marie-aux-Mines, as the district is already adequately served by railways. This unexpected rejection of the scheme has aroused indignant local protests, and it is feared that the Cornimont-La Bresse-Metzeral tunnel will share the same fate. Only two tunnels through the Vosges will therefore probably be constructed.

The Rhine-Rhone Canal.

The putting into service of the Rove tunnel between Marseilles and Port de Bouc practically completes the waterway between Marseilles and Strasburg, but there is still much to be done to permit of the navigation of barges from the Rhine. The waterway is in four sections, that is to say, from Strasburg to Saint-Symphorien by the canal from the Rhine to the Rhone, Saint-Symphorien to Lyons by the Saône, Lyons to Arles by the Rhone, and Arles to the sea by the two canals to Port de Bouc and Marseilles. The total distance is 571 miles. The difficulty at present lies in the insufficient depth of the canal from the Rhine. This canal is only 1·40 m. deep instead of 1·80 m., and at times it falls to 1·10 m. Navigation is particularly difficult in the canalised section of the river Doubs between Montbéliard and Dole. The completion of this waterway is deemed to be so urgent that the Chambers of Commerce of Lyons and Strasburg have each voted a sum of a million francs to permit of the work being put in hand at once. An added importance has been given to the inland waterways by the continued increases in railway rates.

Sailing Ships.

Nantes is one of the last ports at which large sailing ships have been built down to recent years, and lately there passed down the Loire nine famous clippers on their way to Lorient to be broken up. These vessels were part of a fleet of thirteen three-masted ships which were built at Nantes between 1898 and 1900 for a company which employed them to bring grain from Australia to France. During the war they rendered inestimable service in transporting foodstuffs, and after the Armistice the company was called upon to refund excess profits to the amount of several million francs. Known as the Martinière Fleet the ships acquired celebrity on account of the debates in the Chamber of Deputies with reference to the war profits which the owners declined to refund. The ships were seized, and since the Armistice have remained in the Loire, undergoing a rapid deterioration until the State decided to sell them to shipbreakers. Nine of the clippers went to Lorient, and four were purchased by a firm at Dunkirk.

Stainless Steel Patents.

The owners of the Brearley stainless steel patents in France have failed in the action for infringement which they brought against a number of French makers. The final decision of the Courts is to the effect that the patents were rendered invalid by prior publication in an English trade journal, and that the steel had been analysed at the Conservatoire des Arts et Métiers before the patents were applied for, so that, in the opinion of the Court, there was no longer any novelty in the invention. The decision that an official analysis is equivalent to publication may therefore be added to the already long list of precautions that must be taken by the patentee.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

256,104. November 27th, 1925.—REGULATION OF FUEL SUPPLY TO MULTI-CYLINDER ENGINES, C. Baulino, Corso Carbonara 4, Genova, Italy.

The object of this invention is to ensure that the several cylinders of a multi-cylinder oil engine each receive an equal share of fuel oil, so that they may all do a fair share of work. It is essential for its working that each cylinder should be served

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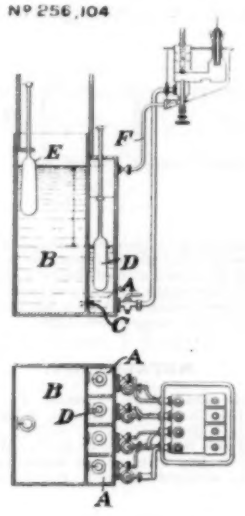

by a separate fuel pump. The several pumps draw their oil from a series of chambers A A, which communicate with a common oil supply tank B through orifices C that are made very carefully of exactly the same size. The floats D D indicate by their height the rate of flow into each pump, while the float E shows the total rate of consumption of fuel. The pipe F is a return drain for leakage oil.—*August 5th*, 1926.

DYNAMOS AND MOTORS.

255,981. May 14th, 1925.—IMPROVEMENTS IN AND RELATING TO DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2, and Alan Adair Pollock, Croxton House, Sherbourne-place, Leamington Spa.

The field punchings A have a series of slots B at the outer edges thereby increasing the radiating surface, the slots being so situated that the material which is not required for the magnetic path is partly cut away and the remainder used as a heat conducting medium. The casing C is ribbed as shown at D, so as to increase the radiating surface of the casing itself, and is provided with an inspection cover E. The end bearing heads F

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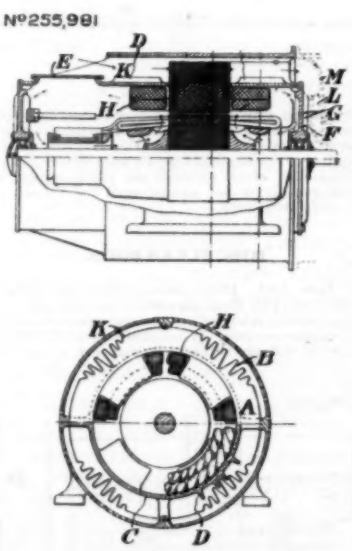

are provided with ribs or fins G and the air inside the main casing C is circulated as shown by the arrows so as to come into contact with the ribs or fins G. The field coils H which surround the punchings are pressed closely against the inner surface of the casing C so that the heat is transmitted from them through to the outer surface of the casing. The air passing through the chamber K in the direction indicated by the arrows may be drawn through by means of a fan L mounted on the shaft, the fan being so enclosed by a bell-shaped member M that the chamber forms the intake for the fan. Where the machine is a generator driven by an internal combustion engine the fan for cooling the radiator may be utilised for drawing the air through the annular chamber. Conversely, air may be forced by a fan through the chamber K, in which case the discharge from the fan is enclosed and connected to one end of the chamber.—*August 5th*, 1926.

255,984. May 16th, 1925.—IMPROVEMENTS IN AND RELATING TO DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, W.C. 2, and Herbert Dreghorn, of 14, Bath-street, Rugby.

This invention relates to dynamo-electric machines and more particularly to alternating-current motors of the type which are provided with commutators. The rotor of the machine comprises two sections A B. A primary winding C connected to slip rings D is arranged to embrace both sections of the rotor core, and each section A B is provided, in addition, with a separate regulating winding E F respectively. Each of these regulating windings has its own commutator G H respectively. The

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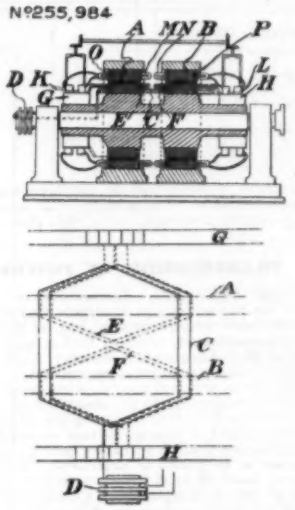

brushes K L of commutators G H are respectively connected to the secondary windings M N on the portions O P of the stator core co-operating with the rotor sections A B. The two sets of brushes K L are so coupled together, for example, by bevel gears and shafting that the same amount of travel is given to each set and the load is shared equally between the two cores. The flux in each core will thus be half the total, so that the voltage per segment of the commutator will only be half that obtained in the arrangements hitherto proposed. It will be understood that this construction may be used in conjunction with resistance connectors, short-pitched coils, and with special windings in which the voltages induced in half coils only are produced between adjacent segments.—*August 5th*, 1926.

BATTERIES AND ACCUMULATORS.

255,967. May 5th, 1925.—IMPROVEMENTS IN AND RELATING TO ELECTRIC BATTERIES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Henry William Hugh Warren, of "Lynn," St. Andrew's-road, Earlsdon, Coventry.

This invention relates to the manufacture of primary electric batteries and more particularly to the type used for supplying the high-tension current to wireless apparatus. The object of the invention is to provide an improved arrangement for connecting up the adjacent cells. The casing A is of sufficient size to contain the number of cells required to give the required voltage. This casing is made of insulating material such as a resinous condensation product or bitumen with a filler, and is provided with partitions B B, which divide the interior of the

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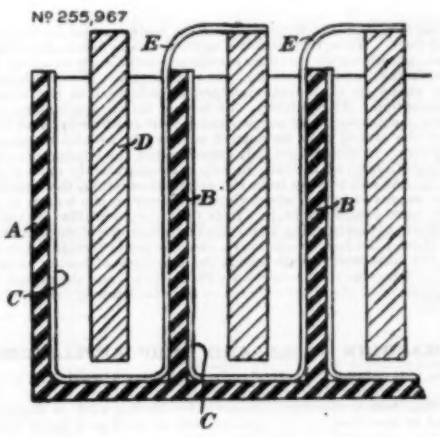


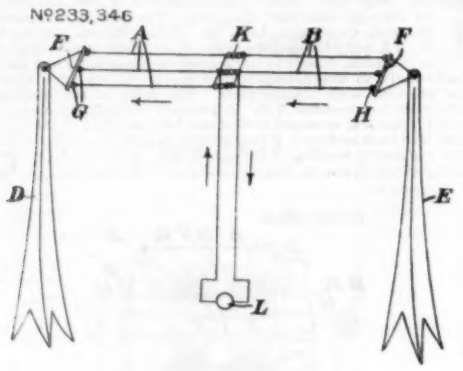
casing into a number of chambers corresponding to the number of cells. In making up the battery the negative electrodes consisting of strips of zinc C bent into U form are inserted into each cell. A positive electrode which may consist of a rod of carbon D provided with a terminal at its upper end is inserted in the middle of each cell and any suitable or usual filling material (electrolyte and depolariser), preferably in the form of a paste, is then inserted in such a way that the two electrodes are retained in their proper relative positions. One limb E of each negative electrode C is made considerably longer than the other, so that it will project above the upper edge of the partition, and this can be bent down so as to engage with the positive electrode of the adjoining cell. The upper ends of each cell may be filled up with pitch to render the whole water-tight and keep the filling in its place.—*August 5th*, 1926.

TELEGRAPHS AND TELEPHONES.

233,346. April 29th, 1925.—IMPROVEMENTS IN OR RELATING TO DIRECTIVE AERIALS, Lucien Levy, of 66, Rue de l'Université, Paris, France.

The object of this invention is to obtain a more intense radiation of energy towards the receiving station and to enhance the propagation of this energy with a minimum of loss. The aerial shown consists of horizontal wires A and B supported between pillars D and E by spreaders F F insulated from the live wires by insulators G and H. The wires A and B are connected

by chains K of insulators. A high-frequency generator L supplies the energy to the aerial. Although at a first glance this aerial appears similar to the vertical T-shaped aerial, it is totally



different therefrom, inasmuch as the two branches of the T are insulated from each other. The principle of an aerial constructed on these lines is fully described.—*July 29th*, 1926.

TRANSMISSION OF POWER.

256,013. June 20th, 1925.—IMPROVEMENTS IN JOINTING SLEEVES OR FERRULES FOR ELECTRIC CABLES, Callender's Cable and Construction Company, Ltd., of Hamilton House, Victoria Embankment, London, E.C. 4, and Alfred Edgar Wilson, of 19, Oaklands-road, Bromley, Kent.

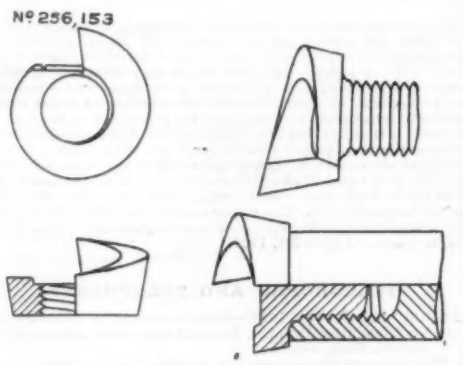
This invention relates to jointing sleeves or ferrules for electric cables and has for its object to provide a one-piece ferrule which can be placed in position round the abutting ends of two cables in a junction or joint box without moving the cables and without removing the amount of insulation that is usually necessary. In the upper drawing A and B are cables having conducting cores C D, which are to be joined in alignment. E is a ferrule or jointing sleeve made of cast, drawn or rolled metal having a longitudinal groove or thin portion F to allow the ferrule to be closed round the bared conductors. When closed the ferrule is intended to be circular in cross section, as shown in the lower illustration, its edges nearly meeting and the space G between

them forming a slot through which the molten metal for the joint can pass. When the ferrule is applied to the bared conductors this space between its edges is enlarged sufficiently to admit the conductors, and the ferrule, when made, may, if desired, have the shape in cross section which is indicated in the middle illustration. Alternatively, the ferrule before application may have a cross-sectional shape similar to that of its finished form and the slot G may be opened sufficiently to admit the conductors. In either case it is closed round the conductors after application so as to leave merely a comparatively narrow slot at G. As will be seen from the upper illustration, the length of the improved ferrule approximates closely to the length of the two bare conductor ends. It is thus very suitable for use in jointing cables entering a junction box where it is often impossible to thread the bared ends into a closed tubular ferrule. The use of the improved ferrule avoids the necessity of baring more of the conductors than is necessary for the joint, and the taping and insulation of the finished joint is thus facilitated.—*August 5th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

256,153. March 19th, 1926.—LATHE TOOLS, J. Gell, 123, Upper Tollington Park, London, N. 4.

This tool is intended primarily for boring work in the lathe and is described in the specification as having a spiral form;

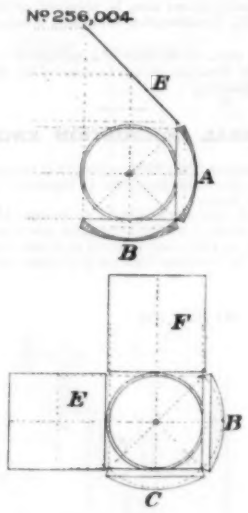


but it seems, as will be seen from the illustration, that the form is rather a spiral helix. The form has the merit that as the tool is ground away on the face the several angles are maintained throughout a long life.—*August 5th*, 1926.

LIGHTING AND HEATING.

256,004. June 8th, 1925.—NON-DAZZLE HEADLIGHTS, A. Brebner, 11, Spencer-road, Putney, London, S.W. 15.

This headlight is provided with three Mangin mirrors A, B and C and two secondary reflectors E and F. Mangin mirrors are adopted on account of their small aberrational divergence, and they are all set at approximately 90 deg. angle to one

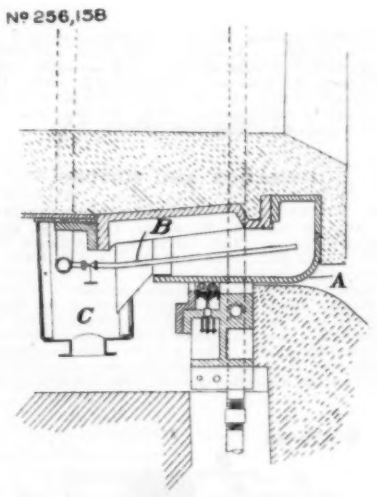


another. The combination projects a compound forward beam of light, comprising a direct beam from the mirror A, another from B reflected by E, and a third from C reflected by F. By the proper adjustment of the reflectors and mirrors the resultant illumination can be so controlled that it will illuminate the road without dazzling effect.—*August 5th*, 1926.

METALLURGY.

256,158. March 30th, 1925.—ROTARY FURNACES, G. de Bethune, 151, Chaussée de Haecht, Schaerbeek-Brussels, Belgium.

The object of this invention is to protect the outlet end of rotary furnaces dealing with molten metals from the eroding effect of the metal as it is discharged. For this reason the outlet

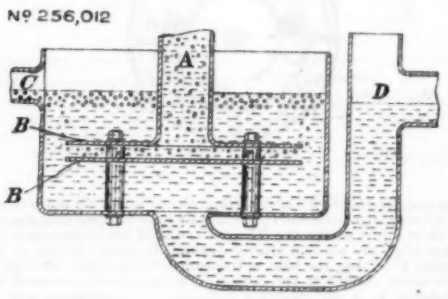


end is surrounded with a hollow casting A, and into this hollow there is projected, by means of pipes B, a stream of cooling water. The spent water escapes by the duct C. It is suggested that the intense cooling of the mouth of the furnace results in an accumulation of material which protects the lining proper, while the whole arrangement is not complicated by valves or closed pockets.—*July 30th*, 1926.

MISCELLANEOUS.

256,012. June 19th, 1925.—SEPARATING OIL FROM WATER, H. Hitchon, The Brae, Kendal, Westmorland.

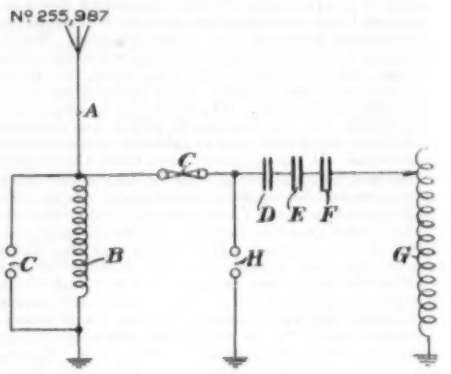
This apparatus is intended for the separation of oil from bilge water and similar services. It comprises a pipe A, through which the mixture is delivered, that terminates in a pair of axially-



spaced discs B B. The mixture, in flowing between these discs, is gradually reduced in velocity so that the oil is allowed to float off and escape by the overflow C, while clear water is taken away at D. Several elaborations of the idea are illustrated in the specification.—*August 5th*, 1926.

255,987. May 19th, 1925.—IMPROVEMENTS IN OR RELATING TO PROTECTIVE DEVICES FOR HIGH-FREQUENCY ELECTRIC SIGNALLING SYSTEMS AND THE LIKE, *Frederick William Le Tall, of 2, Norfolk-street, Strand.*

This invention relates to high-frequency signalling systems and has for its object to provide a protective device in which an overhead or elevated conductor is employed so that the system will be substantially protected from the effects of lightning discharge, static atmospheric discharge, contact with high-voltage conductors, and similar disturbances. An elevated conductor A is connected through an inductance B, which is shunted by a spark gap C to earth. The junction of the elevated conductor A with the inductance B is connected through a fuse C and



three insulating condensers D, E and F to the primary inductance G of a receiver for high-frequency electric signals. The inductance G is connected at its lower end to earth and to other apparatus used for reception. Another spark gap H is connected between earth and the junction of the fuse C and condenser D. The value of inductance B is such that it offers quite low reactance to the flow of currents of relatively low frequency such as may be introduced in the elevated conductor A by proximity to or contact with power mains, while at the same time it offers very great reactance to alternating currents of high frequency such as are used in signalling. The capacity of the three condensers D, E and F is such that they offer very great reactance to low-frequency current, while they offer quite a small reactance to currents of the signalling frequency.—*August 5th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY TO SATURDAY, SEPTEMBER 10TH TO 18TH.

NATIONAL RADIO EXHIBITION.—Olympia, London. W. 1. 10.30 a.m. each day.

UNIVERSAL SMOKE ABATEMENT EXHIBITION.—Bingley Hall, Birmingham.

TO-DAY.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting at Middlesbrough. 2 p.m.

SATURDAY, SEPTEMBER 11TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District meeting at Great Yarmouth. 11 a.m.

MONDAY, SEPTEMBER 13TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the Salford Ironworks of Mather and Platt, Ltd.

TUESDAY, SEPTEMBER 14TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower Hill, London, E. 1. Paper, "Steam Pipes for Super High Pressure," by Mr. J. A. Aiton. 6.30 p.m.

TUESDAY TO THURSDAY, SEPTEMBER 14TH TO 16TH.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS.—Annual meeting and Conference at Newcastle-upon-Tyne. For programme see page 229.

FRIDAY, SEPTEMBER 17TH.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. Paper, "Spun Pipes: Cast Iron and Concrete," by Mr. P. H. Wilson. 7.30 p.m.

SATURDAY, SEPTEMBER 18TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting of North-Eastern and Yorkshire Districts at Whitby. 12 noon.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting at Epsom. 11 a.m.

THURSDAY, SEPTEMBER 30TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Presidential address by Sir Seymour B. Tritton. 7.15 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—East Midland District meeting at Gainsborough. 11 a.m.

WEDNESDAY, OCTOBER 6TH.

INSTITUTION OF SANITARY ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Reception and conversazione. Paper, "Housing Problems, with Special Reference to Subsidies and Rural Needs," by Mr. G. B. Chilvers. 6.30 p.m.

CONTRACTS.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., inform us that it has secured the contract for extensions which are to be carried out in the Belfast power-house.